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ABSTRACT

A study examined and compared writing with and without microcomputers in the elementary schools. Specifically, the study examined (1) how the products of writing instruction with a computer differ from the products of traditionally taught writing, (2) the process of teaching writing, (3) teacher-pupil roles when pupils are writing, (4) teacher attitudes toward writing, (5) student attitudes toward writing, and (6) reading scores of pupils who write with microcomputers as compared with those of pupils who do not use microcomputers. Subjects, 90 teachers and 180 students from grades 1, 3, and 6 in the Toronto (Canada) public schools, were divided equally into three control and three experimental groups, according to grade level. The experimental groups used microcomputers for writing while the control groups used traditional methods. Findings indicated that elementary school children, particularly those in the primary grades, increased and improved their writing by using microcomputers and that such results could be obtained in a classroom in a six-month period with only a few computers. Findings also indicated that, for the students, the process of writing with microcomputers differed from the process of writing with traditional tools, and that it differed by grade level. Results suggested that the use of microcomputers for teaching writing in the elementary grades is compatible with the philosophy of teaching writing encouraged by the Ontario Ministry of Education and the Language Study Centre of the Toronto Board of Education. (References, six appendixes, and 32 figures are attached.) (NKA)

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WRITING WITH MICROCOMPUTERS IN THE ELEMENTARY GRADES

Process, Roles, Attitudes, and Products

Education and Technology Series

U.S. DEPARTMENT OF EDUCATION
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ABSTRACT

The purpose of this research study was to qualitatively and quantitatively examine and compare writing with and without the use of microcomputers in elementary schools. The process of teaching writing, teacher-pupil roles, teacher and pupil attitudes, teachers' philosophies about teaching writing, reading scores, as well as the products of writing were all examined.

The study involved pupils and teachers in Toronto Board of Education schools in Grades 1, 3, and 6. A total of 90 teachers and 180 pupils participated. There were 15 teachers and 30 pupils in an experimental group and 15 teachers and 30 pupils in a comparison group at each grade level. The experimental groups used microcomputers for writing while the comparison groups used traditional tools.

The findings of the study demonstrated that elementary children, particularly those in the primary grades, write more and write better with microcomputers than they do with traditional tools. Such results can be obtained in a regular classroom environment with very few microcomputers and within six months. The study also demonstrated that the process of writing with microcomputers is different in several respects. It is different from the process of writing with traditional tools and it differs by grade level.

Finally, various aspects of the study suggest that the use of microcomputers for teaching writing in the elementary grades is compatible with the philosophy of teaching writing encouraged by the Ontario Ministry of Education and the Language Study Centre of the Toronto Board of Education.

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Adam Beck
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INTRODUCTION

The philosophy and policy for teaching writing to children in the elementary grades as put forward by the Ontario Ministry of Education and the Language Study Centre of the Toronto Board of Education has much in common with what educational literature on writing with microcomputers has to say. Documents published by the Ontario Ministry of Education (1975 a, b; 1977) and the Language Study Centre of the Toronto Board of Education (1977, 1980) provide a general philosophy of teaching writing that emphasizes doing a lot of writing, experimentation, self-editing, revision, student-teacher conferences, individualization, peer evaluation, and edited, typed, displayed material. The literature on the use of microcomputers in education, on the other hand, contains a great deal of anecdotal evidence that suggests that this philosophy of teaching writing can be facilitated by using microcomputers in elementary classrooms. Several authors (Collins, 1983; Kane, 1983; Kleiman and Humphrey, 1982; Larter et al., 1983; Olson, 1983; and Piper, 1983) claim that with the use of word processors and text editors, students not only produce longer pieces of writing, but edit, revise, and experiment more to produce better writing. Microcomputers may also facilitate peer evaluation and "on-the-spot" teacher evaluation of writing.

The purpose of this research study was to qualitatively and quantitatively examine and compare writing with and without the use of microcomputers in elementary schools. More specifically, the purposes were:

- to examine, document, and compare the process of teaching writing;
- to examine, document, and compare pupil-teacher roles when pupils are writing;
- to evaluate and compare pupil attitudes toward writing;
- to evaluate and compare teacher attitudes toward teaching writing;
- to evaluate and compare the products of writing;
- to investigate whether products of computer writing differ for teachers who teach writing according to policy and those who do not;
- to compare reading scores of pupils who write with microcomputers with those pupils who do not.

The study involved pupils and teachers in Toronto Board of Education schools in Grades 1, 3, and 6. Initially 90 teachers and 180 pupils participated. There were 15 teachers in an experimental group and 15 teachers in a comparison group at each grade level.

Originally, the intention was to ask teachers to volunteer for the study and then to assign them randomly to the experimental and comparison groups. However, only 50 teachers volunteered and all expressed a strong desire to be in the experimental group. A few were randomly assigned to the comparison group, but most were placed in the experimental group as they requested. It was then necessary to make a special effort (under very stringent time-lines as the study had been delayed two months in its initiation) to recruit more teachers for the comparison group.

This was finally achieved, and the comparison teachers were offered $200 worth of classroom materials in acknowledgement of their co-operation. The effect of these unexpected circumstances was that teachers were not randomly assigned to experimental and comparison groups as originally planned.

The teachers were asked to choose two pupils (one boy and one girl) from their classes whose birthdays were closest to January 1. This meant that the samples of students in each group were random representatives of each classroom, compensating somewhat for the inability to assign teachers randomly to experimental and comparison groups. Letters describing the study and consent forms were sent home with pupils. If a parent refused to have a child participate, a child whose birthday was next closest to January 1 was selected.

Teacher In-service

A consultant was hired to give the experimental teachers an in-service on the operation of the microcomputers and on the use of the word processing software. Teachers were not instructed on how to incorporate microcomputers into classroom writing activities; the intent was to have them explore and experiment with the microcomputers. Teachers were grouped by grade for the in-service. Five sessions of lessons and two optional practice sessions were held during October and November of 1985.

Instrument Development

The research instruments were developed by the principal investigator and the research assistants within a very short time span because board permission to proceed with the study was delayed several weeks. These instruments were classroom observation schedules, pupil and teacher attitude scales, pupil and teacher interview schedules, and other rating scales and questionnaires. Both pre- and postphase instruments were developed. In some cases, instruments evolved as the study progressed. Some pilot testing of the instruments was done in a few classrooms not participating in the study; however, limitations of time seriously curtailed full pilot testing. Ideally, the teacher and pupil attitude scales should have been administered to a

large number of teachers and pupils and then factor analysed prior to being administered as part of the study; this was not possible.

Due to space limitations, the instruments have not been included in this report in their original format; rather, they have been incorporated into the text and the discussion of the results. Anyone interested in seeing the instruments is asked to contact the principal investigator.

Hardware and Software

The Toronto Board of Education purchased the following hardware for the research study:

	Number
Microcomputer - Commodore C64	80
Monitor - TEO - Amber, 12"	80
Disk Drive - Commodore 1541	50
Printer - TEO - CP80 with built-in interface for joining to Commodore C64	50

Grade 1 experimental teachers received one microcomputer and a set of peripheral equipment. Grade 3 and most Grade 6 teachers received two microcomputers. A few Grade 6 teachers received three microcomputers.

STORY WRITER and STUDENT WRITER, developed by staff of the Toronto Board of Education, were the main word processing software used in the study. It was recommended that STORY WRITER be used mostly for Grade 1 pupils, STUDENT WRITER for Grade 6 pupils; and both for Grade 3 pupils, depending on their abilities. TYPEAWAY, developed by the Association of Large School Boards in Ontario, is software for teaching and testing keyboarding skills; it was also given to all experimental teachers in the study. In addition, extra diskettes were distributed to all the experimental teachers.

Phases of the Study

Throughout the report, reference is made to three phases. The phases are not only based on time, but also on the types of writing samples collected.

a) Prephase; Paper Writing

This phase of the study ran from the beginning of October, 1985 through to the end of December, 1985. During this phase, all children in the experimental and comparison groups wrote with traditional tools. The teachers were each given two file folders, one for each randomly selected pupil. The teachers were directed to put all pieces of each child's writing in the folders, with the proviso that the child agreed to have it placed there.

During this phase, reading tests and attitude scales were administered. Teachers and pupils were interviewed and all classrooms observed.

At the very end of this phase, the computers were placed in the experimental classrooms and teachers were directed to have the pupils practise keyboarding skills, using the TYPEAWAY program.

b)Postphase; Computer Writing

This phase of the study ran from the beginning of January, 1986 through to the end of June, 1986. During this phase, all children in the experimental group used computers for writing while the children in the comparison group continued to write in the traditional manner. Writing from both groups was again collected.

During this phase, reading tests and attitude scales were again administered. Teachers and pupils were interviewed and all classrooms observed. Keyboarding skills were also assessed.

c) Postphase; Paper Writing

The experimental children who did writing on the computers, also did traditional writing on paper. Teachers and pupils continued to place this writing in the folders as well. The researchers had not anticipated this set of data, but realized its value and included it in the data analyses, as a separate phase.

Data Analyses

For many of the variables, t-tests were done on pre- and postmeans followed by covariate analyses that tested postmeans while controlling for differences in premeans. Such analyses were done for the variables of reading, quantity of writing, quality of writing, pupil attitudes, and teacher attitudes.

The details of all these statistical tests are provided in the tables in the appendices. The tests that are statistically significant at the 0.05 level of significance are discussed and graphically illustrated in the main text. Statistically significant t-tests on pre- and postmeans are highlighted in the text and figures with an "*". Statistically significant covariate tests on postmeans are highlighted with a "+".

For observation and interview schedules, frequency counts of responses were tabulated and then examined for large changes from pre- to postphases.

Pearson product moment correlations were calculated to examine relationships between the variables of quality of writing, quantity of writing, and reading. Pearson correlations were also used to determine interrater reliabilities for several variables.

Limitations and Difficulties

This study was conducted in a very natural environment, not an artificial, experimental setting. Consequently, various circumstances somewhat altered the design of the study and other difficulties led to a series of frustrations that might be expected in any school system that introduces microcomputers into elementary classrooms. Several of these limitations and difficulties are outlined here so that readers can maintain a proper perspective while considering the implications of the findings.

For political and financial reasons, the study was delayed two months in its initiation during the fall of 1985, and also discontinued in the spring of 1986. The initial delay meant that there was little time to prepare the system for the study and the problems encountered in recruiting 90 teachers for the study meant that full random assignment to the experimental and comparison groups was not possible. The initial limitations of time precluded proper development of the pupil and teacher attitude scales and adequate pilot-testing of interview and observation schedules. Short time lines meant that the in-service for the experimental teachers was planned and executed very quickly; some teachers felt it could have been better. There was also little opportunity to educate the teachers about the purposes of the study and their attendant roles - most communication about the study was done through memos and telephone calls. Finally, the cancellation of the study after one year means that there is no way of saying whether the results would be the same after two or three years of using computers.

Placing microcomputers in classrooms and keeping them in working order is certainly more costly and complicated than placing traditional writing materials in classrooms. For this study, the cost was an unexpected $8,000 for the materials and labour. For a variety of reasons (including financial ones), the installation of the power bars was delayed, meaning that not all classrooms were able to begin using TYPEAWAY in December and the word processing programs in early January as called for in the original proposal. Several teachers were disappointed in this respect. After the microcomputers and peripheral equipment were finally installed, a number did not work for one reason or another and had to be repaired by board technicians and/or returned to the manufacturer. In several instances, these problems persisted for a number of weeks leading to considerable frustration on the part of everyone involved. A couple of teachers simply gave up and had to be withdrawn from the

study. In some classrooms, it meant that the students' time on the computers from January through June was substantially reduced.

Attrition of subjects can be expected in most social science research and did occur in this study. Unfortunately, because of mechanical and technical problems with the microcomputers, the attrition in this study is higher for the experimental groups than for the comparison groups. The N's used for each statistical test are indicated in the tables in the appendices. The N's vary from test to test depending on whether both pre- and postdata were available for any particular child or teacher and on whether the subject had been lost from the study.

QUANTITY OF WRITING

There are many anecdotal reports in the educational literature that suggest that students write more words when using microcomputers than they do when using traditional tools. The reports claim that students produce more because they like computers, find them physically easy to manipulate, take pride in the neat, professional-looking product and can delay correction of mechanical and grammatical errors to final drafts. Some authors (Piper, 1983; Kleiman and Humphrey, 1982) claim that this combination of circumstances that motivate students to write more means that they become, through practice, better writers.

The question then is "Do children who write with microcomputers write more than children who use only traditional tools?". Every piece of writing (N=3,097) that the children voluntarily placed in their writing folders was analysed to answer this question. The average number of words per piece of writing was then calculated for each child for each phase of the study. Definitions of "a piece of writing" and "a word" were devised (see Appendix A).

For the purposes of statistical analyses, the following grand averages were then determined for the experimental and comparison group: (additional statistics are provided in Appendix A):

- average number of words per piece of paper writing per group (prephase);
- average number of words per piece of paper writing per group (postphase);
- average number of words per piece of computer writing for experimental group (postphase).

Do Children Write More With Computers?

a) Grade 1

Before the computers were placed in the classrooms of the experimental group, both groups wrote with traditional tools only and, on the average, the experimental children wrote fewer words per piece of writing than did the comparison children (7.99 vs. 12.02). In the postphase of the study, the experimental children wrote with computers while the comparison children continued to write with traditional tools. The results indicated that the experimental children wrote more words per piece on the computers than did the comparison children on paper (44.38 vs. 30.31). Neither of these differences are statistically significant. However, when the postaverages are tested controlling for the preaverages, the results are statistically significant and favour the experimental children. This significant difference is shown graphically in Figure 1.

b) Grade 3

In the prephase, the experimental children wrote on average fewer words per piece of paper than did the comparison children. This difference (92.01 vs. 118.90) is statistically significant. In the postphase, the experimental children wrote more on computers than did the comparison children on paper (168.34 vs. 144.26). While this postdifference is not statistically significant even after controlling for preaverages, it does show that the experimental children had gained considerably from the prephase when they were statistically behind. This gain is shown in Figure 2.

c) Grade 6

Pre- and postdifferences were not statistically significant. In the prephase, the experimental children wrote more on paper than did the comparison children (235.01 vs. 231.85). In the postphase, the comparison children wrote more on paper than did the experimental children on computers (319.31 vs. 238.08).

Do Children Write More on Paper While Experiencing Writing on Computers?

a) Grade 1

During the prephase, the experimental Grade 1 children wrote fewer words per piece of paper writing than did the comparison children (6.46 vs. 12.02). During the postphase, they wrote more words on paper (35.41 vs. 30.31). This postphase difference is statistically significant and remains so when controlling for prephase averages. The results are represented graphically in Figure 3.

b) Grade 3

During the prephase, the experimental children wrote significantly fewer words per piece of writing than did the comparison children (82.84 vs. 118.90). During the postphase, they were writing approximately the same number of words (145.74 vs. 144.26). This change is illustrated in Figure 4.

c) Grade 6

No statistically significant differences were found for these children. The comparison children wrote slightly more words per piece during the prephase (231.85 vs. 226.49) and moved ahead even further during the postphase (319.31 vs. 224.11).

Do Children Write More With Computers Within a Given Time Period?

To answer this question, the investigators observed the children as they wrote for a period of ten minutes and then counted the number of words they had written. Every effort was made to complete the exercise in as natural a setting as possible. This task was done twice - once in March and once in May. In March, the experimental children at all three grade levels wrote on average more words on the computer than did the comparison children on paper. These differences were not statistically significant. In May, the differences had increased and were statistically significant for the Grade 3 children and very close to significant for the Grade 1 children. The May averages are as follows (see Appendix A for more details):

	Average No. of Words (10 minute interval)	
	Experimental (Computers)	Comparison (Paper)
Grade 1	12.15	5.41
Grade 3	38.21	24.07
Grade 6	48.48	33.89

The program TYPEAWAY includes a test of both typing speed and typing accuracy. The experimental children were tested on these dimensions in April. With respect to typing speed, the average words per minute for Grades 1, 3, and 6, were, respectively, 1.21, 3.64, and 5.25. It is interesting to note that when these figures are multiplied by 10 to get 12.1, 36.4, and 52.5, the results compare very closely with the results of the ten-minute observations discussed above.

In terms of accuracy, the program determines the percentage of words accurately copied (typed) as measured against the text presented to the pupil. The average accuracy for Grade 1 was 72.96%; for Grade 3, 90.18%, and for Grade 6, 93.54%.

How Much Time Did the Children Spend Writing on the Computers?

Both pupils and teachers were asked to estimate and keep records of the amount of time the children spent writing on the computers. The total time in hours from January through June was calculated for each child. The maximum time, the minimum time, and the average time for each grade level are as follows:

Time (in Hours) Spent Writing on Computers
(January through June)

	Minimum	Maximum	Average
Grade 1	4.1	52.0	10.9
Grade 3	3.3	62.6	21.6
Grade 6	3.3	46.5	14.2

Summary

The Grade 1 experimental pupils wrote more words on computers than did the Grade 1 comparison pupils using traditional tools. In a given time frame of 10 minutes, they wrote approximately twice as many words. Over a six-month period, they had increased the average length of their pieces of writing by 36 words, while the comparison children had increased the average length of their pieces of writing by 18 words. In addition, the experimental children were writing more words with traditional tools.

The Grade 3 experimental pupils wrote more words on computers than did the Grade 3 comparison pupils using traditional tools. In a given time frame of 10 minutes, they wrote an average of 14 words more. Over a six-month period, they had increased the average length of their pieces of writing by 76 words, while the comparison children had increased the average length of their pieces of writing by 25 words. At the beginning, the experimental children were writing fewer words per piece of writing than were the comparison children; during the computer phase of the study, they were writing more words on the computers and the same number of words with traditional tools.

Statistically speaking, the Grade 6 experimental and comparison pupils were writing the same number of words throughout all phases of the study.

QUALITY OF WRITING

In 1983, Kane wrote:

> ...there is some evidence that the computer can be used to promote involvement with composing, focus attention on the overall organization of the text, provide opportunities for practising revision procedures, and create a context for experimenting with alternative texts. (p. 3)

In this study, the quality of the experimental and comparison pupils' writing was analysed both holistically and analytically. The primary question is: "Do children who write with computers write better than children who use only traditional tools?".

Holistic Evaluation of Writing

Every piece of writing (N=3,097) that the children placed in their writing folders was holistically evaluated by the two research assistants. The evaluation was done on a 10-point scale. The scores for the pieces of writing done by each child at each phase of the study were then averaged for each research assistant. Interrater reliabilities were calculated on these averages and are shown in Appendix B.

For the purposes of statistical analyses, the following grand averages were then determined for the experimental and comparison groups (additional statistics are provided in Appendix B):

- average prephase score for paper writing per group for each grade;
- average postphase score for paper writing per group for each grade;
- average postphase score for computer writing for the experimental group for each grade.

a) Do Grade 1 Children Write Better With Computers?

Before the computers were placed in the classrooms of the experimental group, both groups wrote only with traditional materials. The pieces of writing done by the experimental group were given holistic scores that were lower than those done by the comparison group (2.80 vs. 4.14). This difference is statistically significant. In the postphase of the study, the experimental children did writing on the computers while the comparison children continued to write on paper. The results of the holistic evaluation indicated that the experimental children wrote better with the computers than did the comparison children with paper (6.31 vs. 5.63). This postphase difference is not statistically significant. However, when postaverages are tested

controlling for the preaverages, the results are statistically significant and favour the experimental children. These results are graphically illustrated in Figure 5.

b) Do Grade 3 Children Write Better With Computers?

In the prephase, the experimental children were rated lower on the quality of their writing than were the comparison children. The difference (5.07 vs. 5.70) is statistically significant. In the postphase, the experimental children were still rated lower (6.25 vs. 6.38), but the difference is reduced and no longer statistically significant. These data are shown graphically in Figure 6.

c) Do Grade 6 Children Write Better With Computers?

In the prephase, the experimental children were rated lower on the quality of their writing than were the comparison children (5.74 vs. 6.40). In the postphase, the experimental children were still rated lower (6.54 vs. 6.71), but the difference is reduced. Neither of the differences is statistically significant, although the prephase difference is very nearly so.

d) Do Children Write Better on Paper While Experiencing Writing on Computers?

At each grade level, the experimental children were rated lower on the quality of their writing done during the prephase than were the comparison children and in each case the differences were statistically significant. Both groups of children continued to write with traditional tools during the postphase. When these pieces of paper writing were holistically evaluated, the experimental group at each grade level was still rated lower; the Grade 3 difference continued to be statistically significant while the differences at Grades 1 and 6 were no longer so. See Tables B1, B2, and B3 in Appendix B.

Analytic Evaluation of Writing

A sample (N=768) of all the pieces of writing that the children placed in their writing folders was analytically evaluated by one research assistant and another person.

The analytic scale used for Grade 1 was composed of five dimensions - Ideas, Organization, Syntax, Punctuation/Capitalization, and Spelling. The analytic scale used for Grades 3 and 6 included these five dimensions plus a sixth one - Usage/Word Choice. Each piece of writing was evaluated by both raters on each dimension according to a 3-point scale (High-Medium-Low). Two pieces of writing were evaluated for each child for each phase of the study and the two scores added so that the highest possible score was 6 and the lowest was 2. Further details on sampling, the analytic scales, methods, and interrater reliabilities are provided in Appendix B.

For the purposes of statistical analyses, the following overall averages were calculated for each dimension (additional statistics are provided in Appendix B):

- average prephase score for paper writing per group for each grade;
- average postphase score for paper writing per group for each grade;
- average postphase score for computer writing for the experimental group for each grade.

a) Do Grade 1 Children Write Better With Computers?

For the prephase, the pieces of writing done by the experimental group were given analytic scores that were lower than those done by the comparison group on all five scales as follows:

	Prephase	
	Experimental	Comparison
Ideas	2.74 *	3.31
Organization	2.14 *	2.83
Syntax	2.52 *	3.26
Punctuation/Capitalization	2.21 *	
Spelling	2.95	3.70

The differences are statistically significant for all scales except "spelling".

In the postphase of the study, the results of the analytic evaluation indicate that the experimental children wrote better with the computers than did the comparison children with paper on four scales as follows:

	Postphase	
	Experimental	Comparison
Ideas	4.43 +	3.94
Organization	3.60 +	3.31
Syntax	4.07 +	3.91
Spelling	4.33 +	4.15

These postphase differences are not statistically significant; however, when postaverages are tested controlling for the preaverages, the results are statistically significant in all four cases.

In the case of the "punctuation/capitalization" scale, the experimental children were still rated lower (3.14 vs. 3.20), but the difference is no longer statistically significant.

These results are graphically illustrated in Figures 7-11.

b) Do Grade 3 Children Write Better With Computers?

In the prephase, the experimental children were rated lower on all six scales as follows:

	Prephase	
	Experimental	Comparison
Ideas	3.74	4.11
Organization	3.08	3.39
Syntax	3.34	3.43
Usage/Word Choice	3.38	3.63
Punctuation/Capitalization	3.44	3.52
Spelling	3.90 *	4.25

The difference for the "spelling" scale is the only one that is statistically significant.

In the postphase, the experimental children writing with computers were rated higher on all six scales as follows:

	Postphase	
	Experimental	Comparison
Ideas	4.82 +	4.48
Organization	4.06	3.98
Syntax	4.16	4.07
Usage/Word Choice	4.42 +	4.16
Punctuation/Capitalization	4.72 +	4.11
Spelling	5.20 +	4.59

None of the postphase differences are statistically significant. However, when postaverages are tested controlling for the preaverages, the results are statistically significant for four scales - "ideas", "usage/word choice", "punctuation/ capitalization", and "spelling". These four results are graphically illustrated in Figures 12-15.

c) Do Grade 6 Children Write Better with Computers?

In the prephase, the experimental children were rated lower on all six scales as follows:

	Prephase	
	Experimental	Comparison
Ideas	4.17	4.33
Organization	3.69	4.14
Syntax	3.65	4.03
Usage/Word Choice	3.54	3.84
Punctuation/Capitalization	4.04	4.45
Spelling	4.50	4.93

None of the differences are statistically significant.

In the postphase, the experimental children, when writing with computers, were rated higher on four scales as follows:

	Postphase	
	Experimental	Comparison
Syntax	4.44 +	4.26
Usage/Word Choice	4.56 +	4.26
Punctuation/Capitalization	5.08	4.95
Spelling	5.50 +	5.22

None of these postphase differences are statistically significant. However, when postaverages are tested controlling for the preaverages, the results are statistically significant for three scales - "syntax", "usage/word choice", and "spelling". These three results are graphically illustrated in Figures 16-18.

d) Do Children Write Better on Paper While Experiencing Writing on Computers?

As previously stated, the experimental Grade 1 children were rated lower on all prephase scales than were the comparison children, and all the scale differences, with the exception of "spelling", were statistically significant. Both groups of children continued to write with traditional tools during the postphase. Again, for all five scales, the experimental children were rated lower than the comparison children. When controlling for prephase differences, however, the postphase differences are not statistically significant.

The experimental Grade 3 children were rated lower than comparison children on all prephase and postphase scales when both wrote with traditional tools. In the cases of "syntax" and "usage/word choice" scales, the differences between the two groups had actually increased so that they were statistically significant when controlling for predifferences (see Figures 19 and 20).

The experimental Grade 6 children were rated lower than comparison children on all prephase and postphase scales when both wrote with traditional tools. In the case of the "ideas" scale, the difference between the two groups had actually increased so that it was statistically significant when controlled for the predifference (see Figure 21).

Teachers' Rating of Improvement in Pupils' Writing

As a further check on the effects of computers on the quality of children's writing, teachers were asked twice (at the end of the pre- and postphases) to "indicate on a 10-point scale their impression of the improvement in the pupils' writing".

The average ratings for experimental and comparison groups for all three grade levels at the end of the prephase were not statistically different. However, at the end of the postphase, the average rating for the Grade 3 experimental group was significantly higher than the comparison group (6.72 vs. 5.48). Additional statistics are provided in Table B10.

Quantity of Writing Correlated With Quality of Writing

Holistic scores of quality were correlated with numbers of words written. The average scores of each child for all phases of the study were the scores that were correlated.

The correlations for the experimental groups at each grade level were all positive and statistically significant at the 0.0001 level. The correlations and numbers of cases for which they were calculated are:

Grade 1 (N=75)	0.56
Grade 3 (N=75)	0.64
Grade 6 (N=69)	0.65

The correlations for the comparison groups at each grade level were all positive and statistically significant at the 0.0001 level. The N's are smaller for these calculations, as the comparison children did not contribute computer writing. The correlations are:

Grade 1 (N=54)	0.81
Grade 3 (N=56)	0.57
Grade 6 (N=58)	0.65

Summary

a) Grade 1

The results of the holistic and analytic evaluations of the writing of the Grade 1 pupils are in perfect agreement. The results indicate that the quality of writing done by the experimental children during the prephase was lower than

that done by the comparison group. However, during the postphase, the quality of writing done on computers by the experimental children was better than that done by the comparison children using traditional tools. It was better when evaluated as a whole and better when evaluated on the dimensions of "ideas", "organization", "syntax", and "spelling". Considering just the holistic scores, which were based on a 1-10 scale, the average pre-post improvement of the experimental children was much greater than that of the comparison children (3.51 vs. 1.49).

The writing the experimental children did during the postphase with traditional tools also improved; in the prephase, it was rated lower than the comparison children; in the postphase, it was rated as equal in quality.

b) Grade 3

The holistic and analytic evaluations of the Grade 3 writing samples revealed similar trends between the results of the two methods. During the prephase, when both groups used traditional tools, the writing of the experimental children was rated as equal to or lower in quality than that of the comparison children. During the postphase, when the experimental children used computers, the writing of the experimental children was rated as equal to or better in quality than that of the comparison children. Considering the holistic scores, the average pre-post improvement of the experimental children was greater than that of the comparison children (1.18 vs. 0.68). Considering the analytic scores, the computer writing of the experimental children during the postphase was better on the dimensions of "ideas", "usage/word choice", "punctuation/ capitalization", and "spelling". The largest difference between the two groups was for the dimension of "spelling": in the prephase, the experimental children were rated lower than the comparison children; in the postphase, they were rated higher.

The quality of the writing that the Grade 3 groups did with traditional tools during the pre- and postphases tended to remain the same. For both phases, the writing of the experimental group was rated as equal to or lower in quality than the writing of the comparison group.

The teachers' ratings of pupils' improvement in writing supported these findings.

c) Grade 6

The holistic and analytic evaluations of the Grade 6 writing samples revealed similar trends in the results of the two methods. During the prephase, when both groups used traditional tools, the writing of the experimental children was rated as equal in quality to that of the comparison group. During the postphase, when the experimental children used computers, the writing of the experimental children was

rated as equal or better in quality to that of the comparison children. Considering the analytic scores, the computer writing of the experimental children during the postphase was better on the dimensions of "syntax", "usage/word choice", and "spelling".

With respect to quality of writing done with traditional tools, the Grade 6 experimental and comparison pupils were mostly rated as equal for both the pre- and postphases.

The teachers' ratings of pupils' improvement in writing tended to support these findings.

READING

Writing is difficult to evaluate, but some educators claim that it can be measured indirectly through standardized tests of reading. Consequently, students' reading skills were assessed twice - once in October/November during the prephase and once in May/June during the postphase. The Co-ordinator of the Toronto Board Language Study Centre recommended the Dolch Basic Sight Vocabulary Cards for testing the Grade 1 children and the Stanford Achievement Test for Grades 3 and 6. Group averages for experimental and comparison groups were calculated at each grade level and statistically analysed (see Appendix C).

Grade 1

The 220 Basic Sight Vocabulary Words make up 50% to 75% of all material children read in the elementary grades. The cards were flashed in front of the children and they were asked to read them aloud. The students' scores were the number of words recognized instantly with no sounding out or spelling. During the prephase, the experimental children recognized fewer words than did the comparison children. The difference between the group averages (24.54 vs. 50.54) is statistically significant. During the postphase, the experimental children still recognized fewer words, but the difference between the group averages (112.46 vs. 126.27) is no longer statistically significant. Improvement of the experimental group in relation to the comparison group is illustrated graphically in Figure 22.

Grade 3

The Reading Subtest: Part B of the Primary Level II Form A of the Stanford Achievement Test was administered during the prephase. The number of correct responses was recorded for each child and group averages calculated. The difference in the averages for the experimental group (36.54) and the comparison group (38.08) is not statistically significant (see Appendix C).

The Reading Comprehension Subtest: Test 2 of the Primary Level III Form A of the Stanford Achievement Test was administered during the postphase. Again, even after controlling for preaverages, the difference between the experimental group and the comparison group (47.68 vs. 52.92) is not statistically significant.

Grade 6

The Reading Comprehension Subtest: Test 2 of the Intermediate Level II Form A of the Stanford Achievement Test was administered during the prephase while the Reading Comprehension Subtest: Test 2 of the Intermediate Level Form B was administered during the postphase. In both instances, the number of correct responses was recorded for

each child and group averages calculated (see Appendix C). Pre- and postdifferences are not statistically different. Preaverages for the experimental and comparison groups respectively were (36.11 vs. 42.71) and postaverages were (41.39 vs. 46.68).

Reading Correlated With Quality of Writing

Pre- and postholistic scores of quality of writing were correlated with reading scores. The correlations for the experimental groups writing with computers at Grades 1 and 3 were positive and statistically significant at the 0.0001 level. The correlation for Grade 6 was positive and statistically significant at the 0.01 level. The correlations and numbers of cases for which they were calculated are:

Grade 1 (N=42)	0.72
Grade 3 (N=50)	0.63
Grade 6 (N=48)	0.35

The correlations for the experimental groups writing with traditional tools for Grades 1 and 3 were positive and statistically significant at the 0.0001 level. The correlation for Grade 6 was positive and statistically significant at the 0.05 level. The correlations and numbers of cases for which they were calculated are:

Grade 1 (N=48)	0.80
Grade 3 (N=44)	0.60
Grade 6 (N=38)	0.34

The correlations for the comparison groups writing with traditional tools for Grades 1 and 3 were positive and statistically significant at the 0.0001 level. The correlation for Grade 6 was positive and statistically significant at the 0.001 level. The correlations and numbers of cases for which they were calculated are:

Grade 1 (N=52)	0.74
Grade 3 (N=46)	0.56
Grade 6 (N=56)	0.48

Summary

During the prephase, the experimental Grade 1 pupils recognized fewer Basic Sight Vocabulary Words than did the comparison Grade 1 pupils. During the postphase, the numbers of words recognized by the two groups were statistically the same. At Grades 3 and 6, reading scores during both pre- and postphases for both groups were assessed as equal.

PUPILS' ATTITUDES TOWARD WRITING

The literature on writing with microcomputers has a great deal to say about attitudes, emphasizing repeatedly that students are more positively disposed to writing with microcomputers than with traditional tools (Hennings, 1981; Schwartz, 1982). Consequently, attitude scales were developed and administered twice - once in October/November and once in May/June. The Grade 1 scale consisted of thirty-three items with three response alternatives (never - sometimes - always) and was administered orally to the children on a one-to-one basis. The Grades 3 and 6 scale consisted of forty-four items with five response alternatives (never - not often - sometimes - quite often - always) and the children completed it themselves. Appendix D provides details of the statistical analyses.

Grade 1

The investigators divided the thirty-three items into seven subscales and calculated subscale totals for each child. Group means for each subscale were also calculated. For all seven subscales, there were no statistically significant differences in the group means for either the pretest scores or the posttest scores. Thus, the attitudes of the experimental and comparison children toward writing were the same in the prephase of the study and remained so in the postphase.

The seven subscales are as follows:

Enjoyment of Writing
- I like to write things in my free time at home
- Writing makes me feel happy
- I like writing letters
- Writing is boring
- I have to make myself write
- Writing makes me feel nervous
- I like to write things even when the teacher doesn't make me
- Writing is my favourite subject
- I like writing stories
- Writing makes me feel stupid
- I like to write things in my free time at school
- I enjoy writing things

Pride in Written Materials
- I like to keep the things I write
- I am proud of the things I write
- I like to show my family the things I write
- I like to show my teachers the things I write
- I like to show my friends the things I write
- My writing looks good on paper
- I like the things I write put up on the wall
- I am a good writer

Difficulty with Writing
- Writing is hard
- It is hard to write my ideas
- Writing makes my eyes tired
- Writing makes my hand tired
- It is hard for me to write a lot of words

Recognition of Good Writing
- When my friends write, I can tell when it is good
- When I write, I can tell when it is good
- When I write, I can tell where my mistakes are

Writing is Useful
- Writing helps me tell people my ideas
- Writing helps me learn new words

Collaboration When Writing
- I like to have my friends help me when I write

Attitude toward Reading
- I am a good reader
- I enjoy reading

Grade 3

The investigators divided the forty-four items into eight subscales and calculated subscale totals for each child. Group means for each subscale were also calculated. The eight subscales are as follows:

Enjoyment of Writing
- I like to write things in my spare time at home
- Writing makes me feel happy
- I like writing letters
- Writing is boring
- I have to force myself to write
- Writing makes me feel nervous
- I like to write things even when I don't have to
- Writing is my favourite subject
- I like writing stories
- Writing makes me feel stupid
- I like to write things in my spare time at school
- I enjoy writing things
- I like writing in all my subjects
- The more writing I do, the better I get

Pride in Written Materials
- I like to keep the things I write
- I am proud of the things I write
- I like to show my family the things I write
- I like to show my teachers the things I write
- I like to show my friends the things I write
- I like the things I write put up on the wall
- I am a good writer
- My writing looks good on paper

Difficulty with Writing
- Writing is hard
- It is hard for me to write about my ideas
- Writing makes my eyes tired
- Writing makes my hand tired
- When I write things, it is easy to get started
- It is hard for me to write a lot of sentences

Recognition of Good Writing
- When my friends write, I can tell when it is good
- When I write, I can tell when it is good
- When my friends write, I can tell where their mistakes are
- When I write, I can tell where my mistakes are

Writing is Useful
- Writing helps me tell people my ideas
- Writing helps me learn new words
- Learning how to write helps me in my other subjects
- When I write, I get lots of ideas

Collaboration When Writing
- I like to have my friends help me when I write

Attitude Toward Reading
- I am a good reader
- I enjoy reading

Writing Habits
- As I am writing, I read what I have written
- When I write things, I keep going until I finish
- It is good to use a plan before I begin writing
- I can make sentences better by changing them several times
- It is good to make changes when I write

The statistics in Table D2 indicate that during the prephase, there were no statistically significant differences between the experimental and comparison group means for all eight subscales. In contrast, two significant results were found among the mean differences of the postphase. For the subscale, "Enjoyment of Writing", the mean for the experimental children was higher. For the subscale "Recognition of Good Writing", the mean for the comparison group was higher. However, for both cases, when postdifferences are tested controlling for predifferences, there are no statistically significant results. Thus, one must conclude that the groups began and ended with very similar attitudes toward writing.

Grade 6

Analyses were done on the same eight subscales as described above for Grade 3. Predifferences and postdifferences between the experimental and comparison group means were not statistically significant. However, when the postdifferences were again tested controlling for the predifferences, the experimental group was significantly different on the subscale "Difficulty with Writing" and the

comparison group was significantly higher on the subscales "Writing is Useful" and "Attitude Toward Reading". Thus, the experimental Grade 6 children, at the end of the study, felt writing was less difficult. The comparison children, however, felt writing was more useful and had more positive attitudes related to reading. These differences are graphically illustrated in Figures 23, 24, and 25.

Summary

The attitudes of the experimental and comparison children at Grades 1, 3, and 6 during the prephase of the study (when all were writing with traditional tools) tested identically.

During the postphase, when the experimental children were writing with computers, the attitudes of the Grades 1 and 3 groups remained equal. However, three differences appeared for the Grade 6 children. The experimental children reported that writing was "less difficult" than did the comparison children, while the comparison children reported that writing was "more useful" and had "more positive attitudes toward reading" than did the experimental children.

TEACHERS' ATTITUDES TOWARD TEACHING WRITING

Grades 1, 3, and 6 teachers were asked to complete a 23 item "Attitude Toward Teaching Writing" scale twice, once during the prephase in October/November and once during the postphase in May/June. The investigators grouped the items into nine subscales and calculated total scores for each teacher for each subscale. The total scores were then used in the analyses to test for differences between the experimental and comparison groups. The nine subscales and the items associated with them are as follows:

Enjoyment of Teaching Writing
- I enjoy reading my pupils' writing
- When I teach writing, I view it as a creative activity
- I have to force myself to teach writing
- I enjoy teaching writing
- Writing is my favorite teaching activity
- Teaching writing makes me feel anxious
- Teaching writing is a satisfying experience
- Teaching writing is boring

Pride in Teaching Writing
- I am proud of the way I teach writing
- I am a good teacher of writing

Difficulty with Teaching Writing
- Teaching writing is difficult
- When I teach writing, it is difficult to know how to proceed

Confidence in Teaching Writing
- Teaching writing makes me feel inadequate
- I know when I teach writing well

Self-Assessment for Improving Methods
- I often reassess my methods of teaching writing
- My methods of teaching writing are improving

Many Sources for Teaching Ideas
- Books and journals about how to teach writing are useful
- I have lots of ideas for teaching writing
- My colleagues are a source of ideas about teaching writing

Importance of Teaching Writing
- Teaching writing is an integral part of all teaching activities
- I wish I could allot more time to teaching writing

Reading Helps Writing
- Reading helps children learn to write

Writing Tools Affect Writing
- The type of writing tool affects writing composition

Grade 1

For seven of the subscales, there were no significant pre- or postdifferences between the Grade 1 experimental and comparison teachers. For the subscale, "Reading Helps Writing", the experimental teachers were significantly more likely to believe this during the prephase. For the subscale "Self-Assessment for Improving Methods", the experimental teachers scored higher during the postphase after controlling for prephase differences (see Figure 26).

Grade 3

For six of the subscales, there were no significant pre- or postdifferences between the Grade 3 experimental and comparison teachers. On the subscale "Self-Assessment for Improving Methods", the comparison group was significantly higher during the prephase. On the subscale "Pride in Teaching Writing", the experimental group was significantly higher during the postphase, although not after controlling for predifferences. On the subscale "Reading Helps Writing", the comparison group was significantly higher during the pre- and postphases although not during the postphase when controlling for prephase differences.

Grade 6

For seven of the subscales, there were no significant pre- or postdifferences between the Grade 6 experimental and comparison teachers. On the subscale "Self-Assessment for Improving Methods", the comparison teachers scored significantly higher during the prephase. On the subscale "Reading Helps Writing", the comparison group scored significantly higher during the postphase, although not after controlling for predifferences.

Summary

The attitudes toward teaching writing for the experimental and comparison teachers of Grades 1, 3, and 6 were very much alike during both the pre- and postphases of the study. Differences were found for just two of the nine subscales. For the subscale "Reading Helps Writing", experimental Grade 1 and comparison Grade 3 teachers scored highest during the prephase. For the subscale "Self-Assessment for Improving Methods", Grades 3 and 6 comparison teachers scored highest during the prephase while Grade 1 experimental teachers scored highest during the postphase.

TEACHERS' REPORTS ON WRITING ACTIVITIES AND PROCEDURES

Three times during the study, all teachers were asked to complete a questionnaire about their classroom writing activities and procedures. The first time was during the prephase in October/November, and the other two were during the postphase in January/February and May/June. The questionnaire was composed of items that were answered on a scale of 1-10 and that were grouped into subscales by the investigators before analyses. The subscales and associated items are as follows:

Teacher Control of Writing Activities
- I choose the time for class writing activities
- I closely monitor my pupils' writing activities
- I am the primary audience for my pupils' writing
- I impose time limits on my pupils' writing activities
- I assign writing topics to my pupils
- My pupils rely on me to supervise their writing activities

Pupil Control of Writing Activities
- I have pupils choose their own writing topics
- My pupils set their own writing goals
- My pupils choose the time they write in class
- I allocate free time for my pupils to pursue their own writing interests
- I encourage my pupils to solve their own writing problems

Teacher-Pupil Collaboration
- In teaching writing, I act as a collaborator
- My pupils and I work together to solve problems that arise during writing

Pupil Involvement in Evaluation
- My pupils participate in the evaluation of their writing
- My pupils evaluate each other's writing

Whole-Class Instruction
- I teach writing on a whole-class basis
- My teaching of writing is directed to the average ability of my class
- I aim to achieve uniform class progress in writing

Small Group Instruction
- I teach writing in small groups
- To teach writing, I group my pupils according to ability

Individual Instruction
- I teach writing on a one-to-one basis
- I encourage my pupils to progress in their writing at their own rate

Teacher as Lecturer
- In teaching writing, I act as a lecturer

Teacher as Arbitrator
- In teaching writing, I act as an arbitrator

Teacher as Facilitator
- In teaching writing, I act as a facilitator

Teacher as Observer
- In teaching writing, I act as an observer

Teacher as Model
- In teaching writing, I act as a model

Teacher as Demonstrator
- In teaching writing, I act as a demonstrator

Teacher as Challenger
- In teaching writing, I act as a challenger

Teacher as Expert
- In teaching writing, I act as an expert

Teaching Writing is a Learning Experience
- Teaching writing is a learning experience for me

Grade 1

During the prephase, the experimental teachers reported that they "acted as lecturers" significantly more often than did the comparison teachers. During the postphase, the experimental teachers reported that they "acted as observers" and that "teaching was a learning experience" significantly more often than did the comparison teachers. However, when controlling for predifferences, the postdifferences were no longer significant.

Grade 3

During the prephase, the comparison teachers were significantly more likely to use "whole-class instruction". This trend remained during the postphase but was no longer statistically significant after controlling for predifferences.

During the postphase, after controlling for prephase differences, the experimental teachers were significantly less likely to report that they "controlled the writing activities of their pupils", significantly more likely to report that "pupils controlled their own writing activities", and significantly less likely to describe themselves as "facilitators". These differences are graphically illustrated in Figures 27, 28, and 29.

Grade 6

During the prephase the experimental teachers were significantly more likely to use "whole-class instruction" and significantly less likely to describe themselves as "facilitators". These trends remained during the postphase but were no longer statistically significant after controlling for predifferences.

During the postphase, after controlling for prephase differences, the experimental teachers were significantly less likely to use "individual instruction", describe themselves as "challengers", and describe themselves as "experts". See Figures 30, 31, and 32.

Summary

Several interesting differences were found between the experimental and comparison teachers' reports of their writing activities and procedures during the postphase of the study.

Grade 3 experimental teachers that used computers, compared with comparison teachers that used traditional tools were:

- less likely to control the writing activities of their pupils;
- more likely to report that pupils controlled their own writing activities;
- less likely to describe themselves as facilitators.

Grade 6 experimental teachers, using computers, compared with comparison teachers, using traditional tools were:

- less likely to describe themselves as experts;
- less likely to describe themselves as challengers;
- less likely to use individual instruction.

TEACHERS' INTERVIEWS

Teachers were interviewed three times during the study, once during the prephase and twice during the postphase. Teachers were asked the same question about each of the two pupils. Some questions remained the same for each interview and others evolved to match the various stages of the study. Some questions were asked of both comparison and experimental teachers and others were asked of only the experimental teachers who were using the computers.

November/February/May Interviews

The following questions were asked of all teachers three times during the study:

1. How would you describe A's (pupil's name) writing at this time?
2(a). Thinking of all the skills that are involved with writing, ranging from spelling to creativity, what are A's strengths?
2(b). How do you help A build on these strengths.
3(a). Thinking of all the skills that are involved with writing, ranging from spelling to creativity, what are A's weaknesses?
3(b). How do you help A overcome these weaknesses?
4. How would you describe A's motivation to write?
5. How would you describe your role with respect to A's motivation?
6(a). What roles do A's peers play with respect to A's writing?
6(b). How does this affect your role as a teacher?
7(a). What is your method of evaluating A's writing?
7(b). What is the focus of your evaluation?
8. How are you acknowledging A's writing?
9. Describe the significance of your role in A's development as a writer.

The responses to these nine questions were coded in detail and counted for experimental and comparison groups at the three grade levels. A search was then made among the counts of responses to find areas where substantial changes had occurred from pre- to postphases in one group but not in the other. A substantial change was defined as one that was associated with at least 25% of the pupils in one group. These changes are reported here for each grade, the many remaining responses that showed no substantial change are not reported.

Grade 1

Two substantial pre-post changes occurred in the experimental group. During the postphase, experimental teachers more frequently reported using "one-to-one conferencing" to help overcome pupil weaknesses in writing. They also described the significance of their role in the development of a pupil as a writer as "facilitator" for more

pupils during the postphase than the prephase. The percentages of pupils are:

	Experimental	
	Pre	Post
One-to-one conferencing to help overcome weaknesses in writing	30%	55%
Role as facilitator in development of pupil as writer	7%	42%

Two substantial changes occurred in the comparison group. Comparison teachers reported they "encouraged peer interaction" for more pupils during the postphase than prephase. They also reported that they used "praise" to acknowledge pupils' writing for more pupils during the prephase than postphase. The percentages of pupils are:

	Comparison	
	Pre	Post
Encourage peer interaction	15%	43%
Use praise to acknowledge pupils' writing	50%	15%

Grade 3

Three substantial changes occurred in the experimental group. Experimental teachers reported that they used "one-to-one conferencing" to help build strengths in writing for more pupils during the postphase than during the prephase. They also reported acknowledging writing by "having pupils share it with other pupils" and by "reading to the teacher" for more pupils during the postphase than prephase. The percentages of pupils are:

	Experimental	
	Pre	Post
One-to-one conferencing to help build strengths in writing	31%	56%
Acknowledge writing by sharing it with other pupils	44%	80%
Acknowledge writing by reading it to the teacher	22%	48%

One substantial change occurred in the comparison group. Comparison teachers reported they focused on creativity and originality in evaluating writing for more pupils during the prephase than during the postphase. The percentages of pupils are:

	Comparison Pre	Comparison Post
Focus on creativity and originality in evaluating writing	47%	17%

Grade 6

Three substantial changes occurred in the experimental group. Experimental teachers reported that they used "one-to-one conferencing" to help build strengths in writing for more pupils during the postphase than during the prephase. They also reported acknowledging writing by "having pupils share it with other pupils" and by "reading to the teacher" for more pupils during the postphase than prephase. The percentages of pupils are:

	Experimental Pre	Experimental Post
One-to-one conferencing to help build strengths in writing	13%	45%
Acknowledge writing by sharing it with other pupils	27%	55%
Acknowledge writing by reading it to the teacher	0%	32%

Four substantial changes occurred in the comparison group. When evaluating pupils' writing, teachers used "individual conferencing" and focused on "individual assessment" for more pupils during the prephase than during the postphase. Teachers reported "no peer interaction" for fewer pupils during the postphase. And, teachers said the significance of their role in the development of pupils' writing was "to provide an opportunity for writing" for more pupils during the postphase. The percentages of pupils are:

	Comparison Pre	Comparison Post
Individual conferences to evaluate writing	63%	37%
Focus on individual assessment for evaluating writing	50%	13%
No peer interaction during writing	37%	12%
Teacher's role is to provide an opportunity to write	0%	25%

February Interviews

The following questions were asked of the experimental teachers in February, soon after the computers were introduced into the classrooms:

1. What is pupil A's (pupil's name) present reaction to the computer?
2. Describe A's present writing activities on the computer.
3. At present, how would you describe the effect of the computer on A's writing?
4. Describe your role with respect to A's present use of the computer.

Grade 1

The teachers described the reactions to the computers of over 80% of the Grade 1 pupils in positive terms. The phrases they mostly used were "likes it", "loves it", "motivated to use it", "interested", and "mildly enthusiastic".

The pupils' writing activities on the computers varied according to the teachers' philosophies and the needs of the children. Pupils were "composing/story writing", "transcribing", "prewriting with letters", "writing with another pupil", and "making patterns".

For many pupils (43%), the teachers felt that February was too early to describe the effect of the computer on their writing. For other pupils, the teachers said there was not yet any significant effect. However, teachers described the effects on a few pupils as "positive", "motivating", and "moderate".

With respect to their role in the pupils' use of the computer, teachers varied considerably in their responses. The most common responses were:

- teaching them how to use it
- minimal/don't have to do anything
- technician
- teacher and pupil edit together
- providing opportunity for pupil to use computer
- significant; it is time consuming

Grade 3

Teachers described the reactions to the computers of over 80% of the Grade 3 pupils positively in the form of two phrases - "likes it" and "loves it".

The writing activities of 65% of the experimental pupils were described by the teachers as "composing/storywriting". Some pupils were "transcribing" and some were still using TYPEAWAY to improve keyboarding skills. Three pupils were editing their writing on the computer.

For many pupils (47%), the teachers felt that February was too early to describe the effect of the computer on their writing. However, teachers described the effects on several of the other pupils as "produces a lot more writing", "positive", and "motivating".

With respect to their role in the pupils' use of the computer, teachers varied considerably in their responses. The most common descriptions were:

- technician
- teacher and pupil edit together
- structuring time for computer use
- teaching them how to use it
- providing opportunity for pupil to use computer
- facilitator
- encourage pupil to be independent
- co-learners

Grade 6

Teachers described the reactions to the computers for 47% of the pupils with the phrase "likes it". "Confident" and "interested" were used to describe several other pupils.

The pupils' writing activities on the computers were described by the teachers as either "transcribing" or "composing/story writing".

For many pupils (47%), the teachers felt that February was too early to describe the effect of the computer on their writing. For others, the teachers said there was not yet any significant effect. Teachers described the effects on a few pupils as "positive", "likes finished product", "better editing", and "more organized".

With respect to their role in the pupils' use of the computer, the most common descriptions were:

- technician
- facilitator
- teaching them how to use it
- getting them to use it as an editing tool
- minimal/don't have to do anything.

February/May Interviews

Twice during the postphase, a number of other questions were asked of the experimental and/or comparison teachers. The responses are discussed separately for each question for each grade.

1. Describe the pupil's keyboarding skills (experimental teachers only).

Grade 1
During the first interview, 100% of the pupils primarily used one hand with one finger. At the time of the second interview, the percentage had dropped to 68% while the others were using both hands and/or more than one finger.

Grade 3
During the first interview, 45% primarily used one hand with one finger. This percentage dropped to 39% during the second interview. Some pupils were touch typing and others were using combinations of one or both hands with one or more fingers.

Grade 6
During the first interview, 66% of the pupils were "hunting and pecking" with both hands and two or more fingers. The others were mostly using one hand with one or more fingers. During the second interview, 40% were "hunting and pecking" with both hands and two or more fingers while 26% had progressed to just "pecking" with both hands and more than two fingers. The remainder were still using one hand with one or more fingers.

2. What types of writing activities is the pupil doing?

Grade 1
Comparison and experimental teachers responded as follows:

	Experimental	Comparison
Composing	63%	93%
Working with previously saved materials	41%	47%
Copying words from another source	46%	77%
Drawing pictures	-	88%
Transcribing from own writing	32%	52%
Dictating to teacher	32%	-

Grade 3
Comparison and experimental teachers responded as follows:

	Experimental	Comparison
Composing	87%	97%
Drawing pictures	-	86%
Transcribing from own writing	74%	71%
Working with previously saved material	55%	71%
Copying words from another source	40%	62%

Grade 6
Comparison and experimental teachers responded as follows:

	Experimental	Comparison
Composing	70%	98%
Transcribing from own writing	90%	93%
Working with previously saved material	68%	92%
Drawing pictures	-	60%
Copying words from another source	-	53%

3. Does the pupil read over his/her writing?

Grade 1
The experimental teachers reported that 86% of the pupils and the comparison teachers reported that 90% of the pupils were reading over their writing.

Grade 3
The experimental teachers reported that 97% of the pupils and the comparison teachers reported that 90% of the pupils were reading over their writing.

Grade 6
The experimental teachers reported that 90% of the pupils and the comparison teachers reported that 97% of the pupils were reading over their writing.

4. Does the pupil revise his/her writing? If so, in what way?

Grade 1
The experimental teachers reported that 57% of the pupils were revising their computer writing and that they were doing so primarily by revising the spelling (57%) and by changing words (36%).

The comparison teachers reported that 53% of the pupils were revising their writing and that they were doing so primarily by revising the spelling (42%) and by changing words (32%).

Grade 3
The experimental teachers reported that 90% of the pupils were revising their computer writing, while the comparison teachers reported that 83% of their pupils were revising. The main types of revisions and the percentages of pupils in each group making them are as follows:

	Experimental	Comparison
Spelling Revisions	85%	72%
Changing Words	74%	59%
Changing Punctuation	76%	57%
Spacing	56%	9%
Changing Sentences	34%	38%
Adding New Material	31%	42%
Paragraphing	30%	10%

Grade 6
The experimental teachers reported that 93% of the pupils were revising their computer writing, while the comparison teachers reported that 88% of their pupils were revising. The main types of revisions and the percentages of pupils in each group making them are as follows:

	Experimental	Comparison
Spelling Revisions	92%	85%
Changing Punctuation	82%	80%
Changing Words	78%	83%
Changing Sentences	60%	70%
Adding New Material	35%	25%
Paragraphing	30%	57%
Removing Material Completely	23%	32%

5. On a 1-10 scale, rate the pupil's on-task behaviour, interest/motivation, peer interaction and teacher-pupil interaction while writing (for experimental pupils, this means on the computer).

Grade 1
The average ratings for each group are as follows:

	Experimental	Comparison
On-task behaviour	7.6	6.8
Interest/motivation	7.7	7.3
Quantity of peer interaction	6.0 *	7.1
Quality of peer interaction	7.3	6.3
Quantity of teacher-pupil interaction	5.0	6.1
Quality of teacher-pupil interaction	8.3	7.8

Statistical tests showed one significant difference between the two groups. Comparison teachers rated "quantity of peer interaction" higher than did the experimental teachers.

Grade 3
The average ratings for each group are as follows:

	Experimental	Comparison
On-task behaviour	8.1 *	6.8
Interest/Motivation	8.6 *	7.2
Quantity of peer interaction	6.0	5.2
Quality of peer interaction	7.7	6.3
Quantity of teacher-pupil interaction	4.6	6.1
Quality of teacher-pupil interaction	8.3	7.8

Statistical tests showed two significant differences between the two groups. Experimental teachers rated "on-task behaviour" and "interest/motivation" higher than did the comparison teachers.

Grade 6
The average ratings for each group are as follows:

	Experimental	Comparison
On-task behaviour	8.3 *	7.2
Interest/motivation	7.9 *	7.4
Quantity of peer interaction	5.7	6.6
Quality of peer interaction	7.4 *	6.8
Quantity of teacher-pupil interaction	4.4	5.9
Quality of teacher-pupil interaction	7.7 *	8.0

Statistical tests showed four significant differences between the two groups. Experimental teachers rated "on-task behaviour", "interest/motivation", and "quality of peer interaction" higher than did the comparison teachers. The comparison teachers rated "quality of teacher-pupil interaction" higher than did the experimental teachers.

6. What is the nature of the interaction of peers with this pupil during writing? What is the focus of that interaction?

Grade 1
The teachers described the peer interaction with the pupils primarily as:

	Experimental	Comparison
Observing	70%	60%
Collaborating	68%	48%
Demonstrating	48%	-
Distracting	36%	42%
Motivating	30%	30%
Focus is Academic	64%	62%
Focus is Technical/Mechanical	61%	30%
Focus is Social	57%	72%

Grade 3
The teachers described the peer interaction with the pupils primarily as:

	Experimental	Comparison
Observing	77%	66%
Collaborating	48%	62%
Modelling	32%	57%
Demonstrating	37%	38%
Facilitating	-	40%
Challenging	-	40%
Motivating	-	40%
Distracting	-	38%
Focus is Technical/Mechanical	74%	-
Focus is Academic	71%	84%
Focus is Social	42%	67%

Grade 6
The teachers described the peer interaction with the pupils primarily as:

	Experimental	Comparison
Collaborating	57%	70%
Observing	55%	42%
Challenging	-	40%
Facilitating	38%	-
Demonstrating	35%	-
Motivating	-	35%
Distracting	-	33%
Focus is Academic	60%	77%
Focus is Technical/Mechanical	57%	-
Focus is Social	47%	67%

7. When this pupil is writing, what is your teaching style/role? When you interact with the pupil, what is the focus of the interaction and who initiates it?

Grade 1
The teachers described their style/role with the pupils when writing primarily as:

	Experimental	Comparison
Facilitator	80%	73%
Observer	80%	75%
Collaborator	68%	50%
Demonstrator	61%	52%
Challenger	59%	67%
Model	50%	30%
Motivator	32%	48%
Focus is Academic	96%	87%
Focus is Technical/Mechanical	79%	-
Focus is Social	38%	45%
Initiated by teacher	63%	42%
Initiated by pupil	63%	73%
Initiated by other pupil	34%	-

Grade 3
The teachers described their style/role with the pupils when writing primarily as:

	Experimental	Comparison
Facilitator	77%	86%
Observer	60%	83%
Collaborator	52%	64%
Demonstrator	42%	62%
Challenger	39%	84%
Motivator	35%	40%

Model	-	34%
Arbitrator	-	33%
Focus is Academic	87%	95%
Focus is Technical/Mechanical	63%	48%
Focus is Social	31%	33%
Initiated by pupil	73%	64%
Initiated by teacher	44%	57%

Grade 6
The teachers described their style/role with the pupils when writing primarily as:

	Experimental	Comparison
Facilitator	57%	72%
Observer	53%	70%
Challenger	43%	68%
Collaborator	40%	58%
Demonstrator	35%	50%
Motivator	35%	45%
Model	-	40%
Arbitrator	-	37%
Lecturer	-	33%
Focus is Academic	78%	97%
Focus is Technical/Mechanical	47%	-
Focus is Social	-	33%
Initiated by pupil	62%	63%
Initiated by teacher	38%	70%
Initiated by other pupil	35%	-

8. What computer program is the pupil using for writing (experimental teachers only)?

Grade 1
Three-quarters of the pupils were using STORY WRITER and a few were using STUDENT WRITER. The remainder were not using a program but were typing letters and making designs on the screen. Computer writing was not collected from these pupils.

Grade 3
One-half the Grade 3 pupils were using STORY WRITER; the other half were using STUDENT WRITER. Two pupils were also using PAPERCLIP.

Grade 6
Most of the pupils (80%) were using STUDENT WRITER. The remainder were using STORY WRITER, PAPERCLIP, and WORD MAGIC.

9. What functions of the computer program is the pupil using for writing (experimental teachers only)?

Grade 1
The percentages of Grade 1 pupils that used various functions are as follows:

- deletion; character by character (86%)
- printing (25%)
- loading (25%)
- saving (14%)
- insertion; character by character (11%)
- erasing whole story - 3%

Grade 3
The percentages of Grade 3 pupils using various functions on their own are as follows:

- deletion; character by character (97%)
- printing (84%)
- loading (77%)
- insertion; character by character (65%)
- saving (55%)
- erasing whole story (31%)
- insertion; line by line (13%)
- deletion; line by line (13%)
- spelling checker (13%)
- change print on paper (6%)

Grade 6
The percentages of Grade 6 pupils that used various functions on their own are as follows:

- deletion; character by character (97%)
- saving (80%)
- printing (80%)
- loading (77%)
- insertion; character by character (50%)
- erasing whole story (38%)
- deletion; line by line (13%)
- spelling checker (13%)
- rearrangement of material (7%)
- insertion; line by line (7%)
- centreing (3%)
- underlining (3%)

10. Does conferencing take place during revision? If so, with whom?

Grade 1
The experimental teachers reported that 71% of the pupils conference while revising and that it is mostly pupil-teacher conferencing. Similarly, 57% of the comparison pupils conference while revising and mostly with the teacher.

Grade 3
Experimental teachers reported that 81% of the pupils conferenced with the teacher, 48% with a peer, and 6% with a group of peers while revising their writing on computers.

Comparison teachers reported that 83% of the pupils conferenced with the teacher and 34% with a peer while revising their writing.

Grade 6
Experimental teachers reported that 80% of the pupils conferenced with the teacher and 67% with a peer while revising their writing on computers. Comparison teachers reported that 90% of the pupils conferenced with the teacher, 57% with a peer while revising their writing.

11. On a scale of 1 to 10, rate the overall effects of the computer(s) on the pupils' writing (experimental teachers only).

The average ratings for each grade are as follows:

	Average Rating
Grade 1	7.3
Grade 3	7.8
Grade 6	6.9

Summary

Many questions were asked of the experimental and comparison teachers in order to describe and compare process and roles. The massive amounts of data showed that, on the whole, the introduction of one, two, or three microcomputers into an elementary classroom does not dramatically change the process of pupils' writing, the process of teaching writing, and the roles of teachers and pupils. However, some changes, as discussed here, did occur.

Grade 1
Teachers reported that Grade 1 children reacted positively to the computers and mostly used them by typing with one hand and one finger. The process of writing on computers differed in three ways from the process of writing with traditional tools. The comparison children were much more likely to be drawing pictures as part of the writing process and copying from other sources. The experimental children sometimes dictated to their teachers.

The results suggest that there may be less peer interaction for Grade 1 children writing on a computer than for those using traditional tools. However, when peer interaction does occur around the computer, it is frequently a demonstration of technical and mechanical techniques.

When computers are in a Grade 1 classroom, teachers are more likely to describe themselves as facilitators, especially mechanical and technical facilitators. They are also more likely to engage in one-to-one conferencing to help pupils overcome their weaknesses in writing. Teachers

reported that both comparison and experimental pupils were reading over their writing and revising it by changing spelling and words.

On a scale of 1-10, the experimental teachers rated the overall effect of the computers on the pupils' writing as 7.3.

Grade 3

Teachers reported that the pupils' reacted positively to the computers, liked writing with them, and produced longer pieces of writing. The ratings the teachers gave the experimental children for "on-task behaviour" and "interest/motivation" were higher than for the comparison children.

The teachers reported that the majority of the experimental pupils were composing and writing stories directly on the computers. They were also transcribing from their own stories, copying from other sources, and working with previously saved material. The activities of the comparison children were much the same, but the majority were also drawing pictures as part of the writing process. Both groups were reported as reading over their writing and revising.

Three interesting changes occurred in process upon the introduction of computers in the experimental classrooms. Teachers did more one-to-one conferencing to help build strengths in writing, more often acknowledged pupil writing by having pupils share it with their peers, and more often acknowledged pupil writing by having them read it to the teacher.

Teacher-pupil and pupil-pupil interactions in the experimental classrooms frequently focused on mechanical and technical details and teachers frequently played a facilitating role in such matters as time-scheduling.

The Grade 3 experimental pupils were not sophisticated in their use of the computers for writing. Their keyboarding skills were not well-developed and they used very basic functions of the word processing programs. On a scale of 1-10, the experimental teachers rated the overall effect of the computers on the pupils' writing as 7.8.

Grade 6

Some interesting changes in process occurred upon the introduction of computers into the experimental classrooms. Teachers did more one-to-one conferencing to help build strengths in writing, more often acknowledged pupil writing by having pupils share it with their peers, and more often acknowledged pupil writing by having them read it to the teacher.

Teachers rated the experimental pupils higher for "on-task behaviour", "interest/motivation", and "quality of peer interaction". However, "quality of teacher interaction" was rated higher for the comparison classrooms.

The Grade 6 experimental children were more likely to be "transcribing" their own written work onto the computers than any other comparison or experimental group in the study. And, as with Grades 1 and 3, the comparison children were drawing pictures as part of the writing process, an activity that was not possible when writing on computers.

Teacher-pupil and pupil-pupil interaction in the experimental classrooms frequently focused on mechanical and technical details. Both teachers and pupils were facilitators and demonstrators with respect to the computers. Grade 6 experimental teachers were not as likely as the comparison teachers to describe their roles as lecturers, models, and arbitrators.

Both experimental and comparison pupils were reading over the material they had written and revising it.

The Grade 6 experimental pupils were not sophisticated in their use of the computers for writing. Their keyboarding skills were not well-developed and they used very basic functions of the word processing programs.

On a scale of 1-10, the experimental teachers rated the overall effect of the computers on the pupils' writing as 6.9.

OBSERVATION OF CLASSROOM ENVIRONMENT

Each experimental and each comparison classroom at each grade level was observed for ten minutes five times; twice during the prephase and three times during the postphase. The researcher observed the classroom for ten minutes, then immediately checked off the most appropriate alternatives and/or made written comments for each of the categories of the observation schedule. The schedule included the following twelve categories:

- placement of desks
- location of microcomputers (postphase only)
- physical location of teacher's desk
- peer interaction and number of peers interacting
- peer interaction and number of pairs/groups
- peer interaction and nature of interaction
- location of teacher
- nature of teacher's movement
- nature of teacher-pupil interaction
- focus of classroom
- teacher style/role
- aspects of writing being taught
- children's writing activities

Analyses of the many data that resulted from these observations strongly indicated that the environment of the classrooms underwent very little change during the year, even after the introduction of microcomputers into the experimental classrooms. The data were examined for substantial changes, which were defined as 25% of the classrooms in one group. Just three changes were found; all for the Grade 1 classrooms:

- during the postphase, more pupils were observed interacting in the experimental classrooms than during the prephase;
- during the postphase, fewer experimental teachers were observed challenging the pupils than during the prephase;
- during the postphase, the focus of the comparison classrooms was less likely to be a pupil than during the prephase.

Several other observations not associated with substantial change are informative:

- "Activity centres" and "small table circles" are the most popular methods of arranging desks and furniture in Grades 1 and 3 classrooms. This is not the case for Grade 6 classrooms;
- At all grade levels, teachers' desks are most frequently placed in corners of classrooms;
- Experimental teachers were rarely located near or observed moving about the microcomputers;
- For all grades, teachers were mostly observed "moving" about the classrooms;

- For all grades, peer interaction involved "one large group", "small groups", "pairs", and "combinations of these";
- The most popular locations for microcomputers at all grade levels were "in an activity centre/lab", "beside the teacher's desk", "in a back corner", "at the centre of a wall", "in an isolated spot", and "in a front corner".

Summary

The observations completed for this study suggest that classroom environment tends to be very stable over the course of a school year. Not even the introduction of one, two, or three microcomputers results in changes that can be observed.

OBSERVATION OF PUPILS WHILE WRITING

Twice during the postphase, the researchers observed the pupils while they wrote. The comparison pupils were observed while they wrote with traditional materials and the experimental pupils while they wrote with computers. The observation period lasted for ten minutes and every effort was made to observe the writing activities in as natural a setting as possible. The observation schedules were made up of several categories and the researchers checked one or more alternatives in each category and/or wrote additional comments. Many data resulted from these observations and cannot all be presented in this document. What is presented are data that illustrate major themes for the comparison and experimental groups and major differences between the two. Data are discussed for each grade separately.

1. Keyboarding Skills (experimental pupils only).

Grade 1
The majority (75%) of the Grade 1 pupils approached the keyboard with "one hand and one finger". Some (18%) were hunting and pecking with "both hands and two fingers".

Grade 3
The Grade 3 pupils primarily used three strategies on the keyboard; "one hand with one finger" (48%), "hunting and pecking with both hands and two fingers" (35%), and "hunting and pecking with both hands and more than two fingers" (23%).

Grade 6
The Grade 6 pupils primarily used four strategies on the keyboard; "hunting and pecking with both hands and more than two fingers" (33%), "hunting and pecking with both hands and two fingers" (32%), "one hand with one finger" (32%), and "one hand with more than one finger" (27%).

2. Types of Writing Activities.

Grade 1
The experimental pupils were primarily "composing" on the computer (77%), "copying words from another source" (18%), and "entering letters" (12%).

The comparison pupils were primarily "drawing pictures" (60%), "composing" (58%), and "copying words from another source" (22%).

Grade 3
Most (92%) experimental pupils were "composing" on the computer.

Most (80%) comparison pupils were "composing". Some were "copying words from another source" (15%) and "working with previously saved material" (12%).

Grade 6
Grade 6 experimental pupils were primarily "composing" (52%) and "transcribing from their own writing" (50%).

Comparison pupils were primarily "composing" (70%), "working with previously saved material" (27%), and "copying words from another source" (12%).

3. Were Pupils Reading Over Their Writing?

Grade 1
Most of the experimental pupils were reading the writing they were doing on the computer; 50% were "reading it silently"; 43% were "vocalizing" it; and 18% were "mouthing" it.

Many (43%) of the comparison pupils were not reading over their writing (as noted previously, many were drawing pictures). However, 30% were "reading it silently" and 26% were "vocalizing" it.

Grade 3
Most (87%) of the experimental pupils were "silently" reading the writing they were doing on the computer.

Similarly, most (80%) of the comparison pupils were "silently" reading over their writing.

Grade 6
The majority (97%) of the experimental pupils were "silently" reading the writing they were doing on the computer.

The majority (73%) of the comparison pupils were "silently" reading their writing; the remainder were not.

4. Were Pupils Revising Their Writing? If So, What Kinds of Revisions Were They Making?

Grade 1
The majority (70%) of the experimental pupils were revising the writing they were doing on the computer. They were mostly revising "spacing" (37%), "spelling" (33%), "words" (20%), "punctuation" (23%), and "typing errors" (23%).

Not as many (27%) of the comparison pupils were revising their writing. They were revising "spelling", "words", "spacing", and "adding new material".

Grade 3
The majority (83%) of the experimental pupils were revising the writing they were doing on the computer. They were mostly revising "spelling" (42%), "typing errors" (43%), "words" (38%), "spacing" (28%), "paragraphing" (23%), and "sentences" (10%).

Not as many (53%) of the comparison pupils were revising their writing. They were mostly revising "words" (28%), "spelling" (22%), and "adding new material" (10%).

Grade 6
Most (97%) of the experimental pupils were revising the writing they were doing on the computer. They were mostly revising "spelling" (43%), "typing errors" (43%), "words" (35%), "punctuation" (27%), "spacing" (27%), and "sentences" (17%).

Not as many (53%) of the comparison pupils were revising their writing. They were mostly revising "words" (32%), "spelling" (23%), and "punctuation" (12%).

5. On a 1-10 Scale, Rate The Pupil's On-Task Behaviour, Interest/Motivation, Peer Interaction, and Teacher-Pupil Interaction While Writing (for experimental pupils, this means on the computer).

Grade 1
The average ratings for each group are as follows:

	Experimental	Comparison
On-task behaviour	7.3	6.5
Interest/motivation	7.4	7.0
Quantity of peer interaction	2.4	4.5
Quality of peer interaction	2.9	4.0
Quantity of teacher-pupil interaction	1.5 *	3.0
Quality of teacher-pupil interaction	6.0	6.4

Statistical tests showed a significant difference between the groups for "quantity of teacher-pupil interaction" favouring the comparison group.

Grade 3
The average ratings for each group are as follows:

	Experimental	Comparison
On-task behaviour	8.1 *	7.5
Interest/Motivation	8.3 *	7.9
Quantity of peer interaction	1.8 *	3.2
Quality of peer interaction	5.0	5.0
Quantity of teacher-pupil interaction	1.7 *	2.0
Quality of teacher-pupil interaction	6.0	6.1

Statistical tests showed a significant difference between the groups for four scales. The experimental group was rated higher on "on-task behaviour" and

"interest/ motivation". The comparison group was rated higher on "quantity of peer interaction" and "quantity of teacher-pupil interaction".

Grade 6
The average ratings for each group are as follows:

	Experimental	Comparison
On-task behaviour	8.2 *	7.2
Interest/Motivation	8.1 *	7.6
Quantity of peer interaction	3.1	4.3
Quality of peer interaction	5.6	4.4
Quantity of teacher-pupil interaction	1.3	1.9
Quality of teacher-pupil interaction	6.5	5.9

Statistical tests showed a significant difference between the groups for two scales. The experimental group was rated higher on "on-task behaviour" and "interest/motivation".

6. When a Peer Interacts, What is The Nature of That Peer's Interaction? What is the Focus of The Interaction?

Grade 1
The researchers described the nature of peer interaction primarily as:

	Experimental	Comparison
Observer	25%	32%
Distractor	25%	50%
Collaborator	-	23%
Focus is Social	23%	40%
Focus is Academic	18%	37%
Focus is Technical/Mechanical	13%	17%

Grade 3
The researchers described the nature of peer interaction primarily as:

	Experimental	Comparison
Distractor	22%	42%
Observer	15%	22%
Collaborator	-	18%
Focus is Technical/Mechanical	20%	17%
Focus is Academic	12%	35%
Focus is Social	12%	40%

Grade 6
The researchers described the nature of peer interaction primarily as:

	Experimental	Comparison
Observer	28%	18%
Distractor	27%	48%
Collaborator	13%	28%
Facilitator	-	15%
Focus is Technical/Mechanical	27%	17%
Focus is Social	23%	43%
Focus is Academic	20%	47%

7. What is The Teacher's Role While The Pupil Writes? If There is Interaction With The Pupil, What Form Does it Take?

Grade 1
The researchers recorded very little teacher-pupil interaction for the pupil writing on the computer. In most instances, teachers were attending to other pupils in the class.

In the comparison group, teacher interaction with the pupil was also somewhat limited. When it did occur, it took the form of "facilitator" (30%), "collaborator" (22%), "observer" (17%), and "motivator" (12%).

Grade 3
The researchers observed very little teacher-pupil interaction for the pupil writing on the computer. In most cases, teachers were attending to other pupils in the class.

In the comparison group, teacher interaction with the pupil was also somewhat limited. When it did occur, it took the form of "facilitator" (30%), "observer" (20%), and "collaborator" (13%).

Grade 6
For both experimental and comparison groups, teacher interaction with the pupil was quite limited. When it did occur, it took the form of "observer", "facilitator", "motivator", and "expert".

8. What Computer Program Is The Pupil Using (experimental pupils only)?

Grade 1
Nearly all the pupils were writing on the computer with STORY WRITER. A few were not using a program, just the keyboard, and a couple were using STUDENT WRITER AND WORD MAGIC.

Grade 3
The programs in use were STUDENT WRITER (55%), STORY WRITER (35%), PAPERCLIP (7%), and WORD MAGIC (3%).

Grade 6
The programs in use were STUDENT WRITER (78%), STORY WRITER (10%), PAPERCLIP (6%), and WORD MAGIC (6%).

9. What Functions of The Computer Program Is The Pupil Using?

Grade 1
"Character by character deletion" was the main function of the computer program that the Grade 1 pupils were using. It was observed in use for 63% of the pupils.

Grade 3
The primary functions in use were "character by character deletion" (85%), "loading" (32%), "character by character insertion" (17%), "saving" (12%), and "printing" (8%).

Grade 6
The primary functions in use were "character by character deletion" (92%), "loading" (37%), "character by character insertion" (23%), "saving" (15%), "line by line deletion" (10%), and "underlining" (8%).

10. How Are Revisions Being Made (comparison pupils only)?

Grade 1
Most (77%) of the comparison Grade 1 pupils were not revising their writing. The remainder were revising by "erasing" and "crossing out".

Grade 3
Many (42%) of the comparison Grade 3 pupils were not revising their writing. Those who were revising were mostly "erasing" (47%).

Grade 6
Many (52%) of the comparison Grade 6 pupils were not revising their writing. Those who were revising were mostly "erasing" (25%) and "crossing out" (12%).

Summary

Twice during the postphase, the researchers observed the experimental and comparison pupils while they wrote. The experimental pupils wrote with computers. Several differences were observed in the writing processes of the two groups at each grade level.

Grade 1
The experimental children were more likely to be composing, reading over their writing, and revising it than the comparison children. While many of the comparison children were composing, many were also engaged in drawing pictures.

The experimental children used the computer in a very basic way. They used the keyboard mostly with one hand and one finger, and their revision mostly took the form of character by character deletion.

More teacher-pupil interaction took place for the comparison group than for the experimental group.

Grade 3

The Grade 3 experimental pupils were rated higher than the comparison pupils for "on-task behaviour" and "interest/motivation". On the other hand, the comparison group was rated higher for "quantity of peer interaction" and "quantity of teacher-pupil interaction".

The keyboarding skills of the experimental pupils were quite unsophisticated. Their use of word processing functions was also very basic involving mostly character by character deletion.

Both experimental and comparison pupils were composing and reading the writing they had done; however, the experimental children were much more likely to be revising it.

Grade 6

The Grade 6 experimental pupils were rated higher than the comparison pupils for "on-task behaviour" and "interest/motivation".

The keyboarding skills of the experimental Grade 6 pupils were more sophisticated than the Grades 1 and 3 children, but there was no touch typing. Their use of word processing functions was very basic mostly taking the form of character by character deletion.

The experimental pupils were not as likely to be composing as the comparison pupils; in fact, many were transcribing their paper writing onto the computer.

While both experimental and comparison pupils mostly read over the writing they had done, more experimental children were revising it.

For both groups, the quantity of teacher-pupil interaction during the observation period was quite limited.

PUPIL INTERVIEWS

Pupils were interviewed three times during the study, once during the prephase and twice during the postphase. Some questions remained the same for each interview and others evolved to match the various stages of the study. Some questions were asked of both comparison and experimental pupils and others were asked of only the experimental pupils who were using the computers.

The following questions were asked three times during the study - once during the prephase and twice during the postphase. Questions marked with an "*" were not asked of the Grade 1 pupils and in a few instances, questions were phrased in simpler terminology for Grade 1 pupils.

1. Can you tell me how you start writing? Materials? Thinking?
2. Can you tell me how you get your ideas? What if you have no ideas?
3. Do you always want to write? Why?
* 4. For whom do you write?
* 5. When you think about the things you have to do when you write, what do you think is most important? Least important?
6. What is the hardest part about writing? Easiest part?
7. What do you like about writing? Don't like?
8. Do you ask your teacher for help when you are writing? If yes, what kind? If no, why not?
9. Even when you don't ask, does your teacher help you with your writing? If yes, how?
10. Do you ask your classmates for help when you are writing? If yes, what kind? If no, why not?
11. Even when you don't ask, do your classmates help you with your writing? If yes, how?
12. Are there certain people in the classroom with whom you especially like to write? Why?
13. Are there times when you like to write by yourself? Why?
*14. How much time do you spend writing a day? A week? When?
15. When you are writing, what takes up most of your time?
16. Do you make a lot of changes when you write? Why? How? If yes, what kind? If no, why not?
17. When you make changes, does anyone help you? Who?
18. How do you know when you have finished?
19. Does anyone help you decide when you are finished? Who?
20. How do you know when you have done a good job?
21. Does anyone tell you if you have done a good job?
*22. Do you know what your teacher thinks of your writing? How?
*23. What kind of writing does your teacher like?
24. Does anyone read your writing? Who? If no, why not? How do you feel about that?

The responses to these twenty-four questions were coded in detail and counted for experimental and comparison groups. A search was then made among the counts of responses to find areas where substantial changes had occurred from pre to postphase in one group but not in the other. A substantial change was defined as one that was associated with at least 25% of the pupils in one group. These changes are reported here, the many remaining responses that showed no substantial changes are not reported.

Grade 1

One substantial change occurred in the experimental group. During the postphase, fewer experimental pupils reported that "drawing a picture" was the first thing they did when making a story (Pre - 43%; Post - 17%).

Two substantial changes occurred in the comparison group. During the postphase, more comparison pupils said they asked their teachers for help with "spelling" than did comparison pupils during the prephase (Pre - 33%; Post - 65%). Also, fewer comparison pupils said "there are certain children in the classroom with whom I especially like to make a story" (Pre - 83%; Post - 55%).

Grade 3

No substantial changes occurred for the experimental group. Two substantial changes occurred for the comparison group. Fewer comparison pupils said they "changed words" in their writing during the postphase (Pre - 50%; Post - 23%). and fewer said their teachers liked "neatness" (Pre - 53%; Post - 27%).

Grade 6

No substantial changes occurred for the experimental group. Two substantial changes occurred for the comparison group. Fewer comparison pupils said they "liked making up and imagining stories" during the postphase (Pre - 43%; Post - 8%) and fewer said they knew they had finished when "I have reached the end of the story" (Pre - 40%; Post - 13%).

The following three questions were asked of the experimental pupils once during the postphase. Their most frequent responses are indicated for each grade level.

1. Tell Me What You Think About The Computer In The Classroom. What Are Your Likes And Dislikes? Is It Hard Or Easy?

	Grade 1	Grade 3	Grade 6
I love it/I like it	47%	40%	13%
It is easy just to push buttons to make letters	33%	17%	-
I like writing my stories on the computer	27%	-	-
I like playing with it	20%	-	-
It is easy	17%	33%	23%
It is hard searching for the letters	13%	-	13%
It is good	10%	-	13%
It is neater	10%	-	20%
Everything is easy	10%	-	-
It is fun	-	30%	17%
Typing is fun/TYPEAWAY is fun	-	10%	23%
Pressing buttons is easy	-	10%	20%
You can do different things on it	-	10%	-
Loading is hard	-	-	13%

2. What Are You Doing On The Computer Now? Are You Writing Stories? When?

	Grade 1	Grade 3	Grade 6
I am writing stories/composing	67%	77%	50%
I am writing my name	17%	-	-
I am playing with it/pressing keys	17%	-	-
I am copying stories/transcribing	10%	-	50%
I am learning how to type	-	20%	-
I am playing games	-	10%	20%
I write on it when it is my turn	27%	13%	13%
I write on it when the teacher tells me	13%	13%	10%
I have written on it once or twice	13%	-	-
I write on it every day	-	27%	-
I write on it once a week	-	17%	23%
I write on it twice a week	-	-	13%
I use it when I get my work done	-	-	23%
I use it during "creative.writing" period	-	-	13%

3. Does Anyone Help You When You Are Using The Computer? Who? How?

	Grade 1	Grade 3	Grade 6
Yes	83%	70%	47%
Sometimes	-	17%	17%
No/Not often	-	-	30%
The teacher helps me	53%	53%	37%
My friends help me	37%	40%	27%

Tells me where the letters are	20%	10%	-
Tells me what the keys mean	20%	17%	13%
Tells me what to do	17%	13%	-
Helps me write the story	13%	10%	-
Shows me how to print the story	10%	-	-
Shows me how to correct mistakes/edit	10%	13%	17%
Helps me load and get started	-	20%	17%

The following two questions were asked of the experimental pupils three times during the postphase. The most frequent average responses are given for each.

1. When You Write On The Computer, Is It Easier, Harder, Or The Same As Writing With Paper And Pencil? Why?

	Grade 1	Grade 3	Grade 6
Easier	48%	63%	47%
The Same	34%	17%	17%
Harder	11%	13%	33%
Pressing buttons is easy	33%	30%	17%
It is easy to erase and correct	-	17%	10%
Searching for letters is hard	-	-	20%
Pencil works faster	-	-	13%

2. When You Write On The Computer, Are Your Stories Better, Worse, Or The Same? Why?

	Grade 1	Grade 3	Grade 6
Better	44%	47%	27%
The Same	44%	43%	67%
Worse	2%	-	-
It looks neater/better	33%	23%	17%
They are the same stories	-	13%	13%
They have the same ideas/author	-	13%	17%
I copy the same story on to the computer	-	-	23%

Finally, a number of additional questions were formulated and asked of the experimental and/or comparison pupils twice during the postphase of the study. The responses are discussed separately for each question for each grade.

1. How Do You Write When On The Computer? (Experimental Pupils Only.)

Grade 1

Approximately 80% of the pupils reported that they used "one hand with one finger". Some of the others said they hunted and pecked with "both hands and two fingers".

Grade 3
Approximately 50% of the pupils reported that they used "one hand with one finger". Many of the others (37%) said they hunted and pecked with "both hands and two fingers".

Grade 6
The Grade 6 pupils mostly used "one hand with one finger" (40%), "hunted and pecked with both hands and two fingers" (38%), and "hunted and pecked with both hands and more than two fingers" (22%).

2. What Do You Do When You Are Writing?

Grade 1
Grade 1 pupils said their writing mostly involved:

	Experimental	Comparison
Writing something new	92%	92%
Rewriting something previously written on paper	45%	42%
Copying words from other sources	43%	55%
Dictating a story to the teacher	37%	45%
Working on writing that had been saved	37%	45%
Entering words/writing words	27%	35%
Entering letters/writing letters	17%	20%
Creating graphics using keyboard characters	13%	-
Copying what the teacher had written	12%	37%
Drawing pictures	-	90%

Grade 3
Grade 3 pupils said their writing mostly involved:

	Experimental	Comparison
Writing something new	92%	83%
Rewriting something previously written on paper	72%	58%
Working on writing that had been saved	68%	57%
Copying words from other sources	48%	55%
Creating graphics using keyboard characters	18%	-
Drawing pictures	-	72%
Copying something written by the teacher	-	10%

Grade 6
Grade 6 pupils said their writing mostly involved:

	Experimental	Comparison
Rewriting something previously written on paper/Transcribing	85%	82%
Writing something new	77%	98%
Working on writing that had been saved	63%	93%
Copying words from other sources	40%	58%
Drawing pictures	-	55%

3. Do You Read Over Your Writing? If So, How, And To Whom?

Grade 1
The majority (72%) of the experimental pupils reported that they "silently" read over the writing they do on the computers; 25% said they read it "out loud". In addition, 75% reported that they read their computer writing to their teachers while 37% said they read it to their peers.

The majority (75%) of the comparison pupils reported that they "silently" read over the writing they do; 25% said they read it "out loud". In addition, 75% reported that they read their writing to their teachers, 58% said they read it to their peers, while 17% said they read it to the class.

Grade 3
The majority (90%) of the experimental pupils reported that they "silently" read over the writing they do on the computers; 12% said they read it "out loud". In addition, 53% reported that they read their computer writing to their teachers while 48% said they read it to their peers.

The majority (82%) of the comparison pupils reported that they "silently" read over the writing they do; 10% said they read it "out loud". In addition, 62% reported that they read their writing to their teachers, while 48% said they read it to their peers.

Grade 6
The majority (90%) of the experimental pupils reported that they "silently" read over the writing they do on the computers. In addition, 35% reported that they read it to their peers and 18% said they read it to their teachers.

The majority (95%) of the comparison pupils reported that they "silently" read over the writing they do on the computers; 28% said they read it "out loud". In addition, 53% reported that they read it to their peers, 37% said they read it to their teachers, and 10% said they read it to the class.

4. Do You Make Changes Or Revise Your Writing? If So, In What Way?

Grade 1
Experimental pupils (using the computer) and comparison pupils reported that they were changing their writing as follows:

	Experimental	Comparison
Changing words	48%	55%
Spelling	40%	60%
Spacing	38%	15%
Correcting typing mistakes	25%	-
Changing sentences	17%	13%

Adding new material	13%	20%
Changing punctuation	10%	-
Correcting letter formation	-	17%

Grade 3
Experimental pupils (using the computer) and comparison pupils reported that they were changing their writing as follows:

	Experimental	Comparison
Spelling	72%	68%
Changing words	70%	65%
Changing punctuation	43%	43%
Correcting typing mistakes	38%	-
Spacing	38%	28%
Changing sentences	37%	33%
Adding new material	25%	17%
Removing material completely	18%	15%
Rearrangement of material without changes	15%	23%
Paragraphing	10%	20%
Correcting letter formation	-	17%

Grade 6
Experimental pupils (using the computer) and comparison pupils reported that they were changing their writing as follows:

	Experimental	Comparison
Spelling	80%	83%
Changing words	78%	83%
Changing sentences	58%	70%
Changing punctuation	55%	58%
Paragraphing	40%	48%
Adding new material	28%	28%
Spacing	27%	20%
Correcting typing mistakes	27%	-
Rearrangement of material without changes	22%	48%
Removing material completely	18%	37%

5. On A 1-5 Scale, Rate Your Interest In Writing, How Often You Work With Your Classmates When You Are Writing, The Helpfulness Of Your Classmates, How Often You Work With Your Teacher When You Are Writing, And The Helpfulness Of Your Teacher (for experimental pupils, this means on the computer).

For each of these scales, there were no statistically significant differences between the experimental and comparison groups at any of the grade levels. There are no large differences between the groups.

6. How Do Your Classmates Work With You When You Are Writing?

Grade 1

Grade 1 pupils described the way their classmates worked with them primarily as:

	Experimental	Comparison
Observer	62%	47%
Collaborator	50%	43%
Distractor	37%	27%
Demonstrator	28%	33%
Challenger	27%	45%
Lecturer	18%	35%
Model	15%	17%
Motivator	-	10%
Focus is Academic	65%	65%
Focus is Technical/Mechanical	42%	25%
Focus is Social	23%	25%

Grade 3

Grade 3 pupils described the way their classmates worked with them primarily as:

	Experimental	Comparison
Observer	45%	28%
Distractor	35%	33%
Collaborator	33%	40%
Challenger	35%	33%
Demonstrator	25%	25%
Lecturer	13%	18%
Model	12%	22%
Motivator	-	10%
Focus is Academic	55%	58%
Focus is Technical/Mechanical	37%	12%
Focus is Social	20%	27%

Grade 6

Grade 6 pupils described the way their classmates worked with them primarily as:

	Experimental	Comparison
Observer	33%	25%
Demonstrator	27%	13%
Challenger	27%	43%
Collaborator	18%	45%
Model	13%	28%
Distractor	13%	23%
Lecturer	12%	10%
Motivator	-	27%
Helper	-	27%
Focus is Academic	48%	82%
Focus is Technical/Mechanical	35%	13%
Focus is Social	20%	32%

7. When You Write, What Does Your Teacher Do?

Grade 1
Grade 1 pupils described the teacher's style/role as:

	Experimental	Comparison
Arbitrator/Time structurer	67%	60%
Instructor of how to use computer	48%	-
Challenger	45%	58%
Demonstrator	40%	43%
Collaborator	38%	33%
Observer	32%	48%
Disciplinarian	23%	48%
Model	23%	18%
Motivator	15%	10%
Lecturer	-	37%

Grade 3
Grade 3 pupils described the teacher's style/role as:

	Experimental	Comparison
Arbitrator/Time structurer	78%	58%
Demonstrator	63%	42%
Observer	55%	52%
Challenger	50%	57%
Instructor of how to use computer	43%	-
Disciplinarian	38%	42%
Model	22%	33%
Collaborator	20%	32%
Motivator	15%	23%
Lecturer	-	20%
Distractor	-	15%

Grade 6
Grade 6 pupils described the teacher's style/role as:

	Experimental	Comparison
Arbitrator/Time structurer	70%	72%
Demonstrator	60%	37%
Lecturer	50%	28%
Challenger	50%	72%
Observer	28%	42%
Disciplinarian	28%	23%
Model	23%	37%
Motivator	13%	28%
Collaborator	-	18%

8. When You Work With Someone When Writing, Whose Idea Is It?

For both experimental and comparison groups at each grade level, 60% or more of the pupils reported that it was their own idea.

9. What Functions Of The Computer Program Do You Use? (experimental pupils only)

The percentages of pupils who reported using various functions at each grade level are as follows:

	Grade 1	Grade 3	Grade 6
Deletion; character by character	90%	93%	82%
Printing	33%	63%	67%
Loading	25%	73%	80%
Saving	17%	53%	65%
Erasing whole story	8%	12%	10%
Insertion; character by character	7%	30%	37%
Spelling checker	-	10%	-
Deletion; line by line	-	-	15%
Underlining	-	-	5%

Summary

Pupils were interviewed three times during the study, once during the prephase and twice during the postphase. Many data were collected and analysed. The major findings are discussed here.

Grade 1

Many of the experimental Grade 1 pupils liked the computers. Many thought it was easier to write with computers than with traditional tools, and many felt their computer writing was better. Most said they used the keyboard with one hand and one finger. Most reported their revisions usually took the form of character by character deletion. A few of the Grade 1 children had learned to load, save, and print.

The experimental and comparison pupils reported a wide variety of very similar writing activities; 92% of both groups were writing/composing new material. The one major difference in writing activities was that 90% of the comparison group reported drawing pictures as they wrote. This activity was not possible when experimental children wrote with computers.

The majority of both groups reported that they read over their writing and that they read it to their teachers. Several children of both groups also reported that they read their writing to their peers.

Patterns of pupil-pupil and teacher-teacher interaction while writing were very similar for both groups, although the experimental pupils frequently spoke of getting mechanical and technical help from the teacher and peers.

Grade 3

Many of the experimental Grade 3 pupils liked the computers. Many thought it was easier to write with computers than with traditional tools, and many felt their computer writing was

better. Most reported unsophisticated keyboarding skills and said they revised by deleting character by character. The majority were loading, saving, and printing.

The experimental and comparison pupils reported a wide variety of very similar writing activities; the majority in both groups were writing/composing new material. The one major difference in writing activities was that 72% of the comparison group reported drawing pictures as they wrote. This activity was not possible when experimental children wrote with computers.

The majority of both groups reported that they read over their writing and that they read it to their teachers. Several of both groups also reported that they read their writing to their peers.

Patterns of pupil-teacher and teacher-pupil interaction while writing were very similar for both groups; although the experimental pupils frequently spoke of getting mechanical and technical help from the teacher and peers.

Grade/6

The Grade 6 experimental children were not as enthusiastic about the computers as the Grades 1 and 3 children; fewer said they liked the computers and found them easy to use.

While the Grade 6 experimental children reported a number of writing activities on the computers that were very similar to the comparison children, they were not as likely to say they were writing/composing something new on the computers. In fact, they were less likely to say they were composing new material on the computers than the Grades 1 and 3 comparison and experimental children. The Grade 6 experimental children reported that they frequently spent time on the computer transcribing their paper writing into the computer. Consequently, it is not surprising that 67% reported the writing they did on the computer was the same as that they did with traditional tools.

Most of the Grade 6 experimental pupils reported unsophisticated keyboarding skills and said they revised by deleting character by character. The majority were loading, saving, and printing.

The majority of both groups reported that they read over their writing, but not many of either group reported reading it to their teachers or peers.

Grade 6 children tended to report getting less help from teacher and peers than did Grades 1 and 3 pupils, although, in a similar fashion, the experimental children spoke of getting mechanical and technical help and more frequently described the teacher's role as demonstrator.

The comparison Grade 6 children tended to speak of peer collaboration more frequently than did the experimental children.

THE PHILOSOPHY OF TEACHING WRITING

The Ontario Ministry of Education and the Language Study Centre of the Toronto Board of Education encourage a philosophy of teaching writing that encompasses the following concepts:

- doing a lot of writing;
- experimentation;
- self-editing;
- revision;
- polishing;
- student-teacher conferences;
- on-the-spot student-teacher interviews;
- individualization;
- peer evaluation;
- fluency and spontaneity before mechanics;
- edited, typed, displayed material.

One purpose of this study was to investigate whether teachers who adhere to this philosophy of teaching writing have pupils who improve in writing more than teachers who do not, particularly when making use of microcomputers to teach writing.

At the beginning of the study, the first task that every teacher was asked to do was to describe how they taught writing. They were asked to do this by answering the following six questions:

- What two aspects of writing do you feel are most important?
- How often do you have your pupils write?
- What two methods have you found most useful in evaluating your pupils' writing?
- What method do you most frequently use to help your pupils improve their writing?
- How do you motivate a pupil who is reluctant to write?
- How do you acknowledge good writing?

The research assistants independently rated the teachers' responses to each question on a 1-10 scale, according to whether they fit the above philosophy or not. A high score meant the teacher was likely to adhere to the philosophy. For the six questions, a top score of 60 was possible. The interrater reliabilities for teachers at Grades 1, 3, and 6 were, respectively: 0.74, 0.63, and 0.80.

The raters' scores were added for each teacher and t-tests were used to assess differences between the group means of the experimental and comparison teachers at each grade level. Means and standard deviations were:

	Experimental		Comparison	
	Mean	Standard Deviation	Mean	Standard Deviation
Grade 1	86.47*	5.08	81.13	10.84
Grade 3	79.77	8.43	83.93	7.72
Grade 6	75.47	13.06	75.04	18.40

The t-tests indicated a statistically significant difference at Grade 1; the experimental teachers were more likely to adhere to the philosophy than were the comparison teachers.

The teachers' "philosophy scores" were then correlated with their pupils' improvement in writing. At each grade level, pre-post gain scores (holistic evaluation) were averaged for paper to paper writing and paper to computer writing.

For the comparison children, pre-post gains (writing with traditional tools) correlated with teachers' philosophy scores as follows:

	Correlation
Grade 1	-0.14
Grade 3	0.03
Grade 6	-0.31

For the experimental children, pre-post gains (writing with traditional tools) correlated with teachers' philosophy scores as follows:

	Correlation
Grade 1	-0.07
Grade 3	0.07
Grade 6	-0.14

For the experimental children, pre-post gains (writing with traditional tools in the prephase and with computers in the postphase) correlated with teachers' philosophy scores as follows:

	Correlation
Grade 1	0.51*
Grade 3	0.24
Grade 6	-0.02

The correlation for Grade 1 was statistically significant.

Summary

At the Grade 1 level, the results suggest that the teachers in the experimental group were more likely to adhere to the Ministry philosophy of teaching writing than were the comparison teachers. In addition, within this experimental group, the pupils who made the greatest gains in quality of writing were more likely to be taught by teachers who strongly adhered to the philosophy. No such relationships were found for the Grades 3 and 6 teachers.

FINAL TEACHER COMMENTS

In June, at the end of the postphase, experimental teachers were presented with seven questions regarding computers in their classrooms. Responses were summarized for each question for each grade. The numbers of teachers who answered each question are shown.

1. What Has Been the Impact of the Microcomputer(s) In Your Classroom?

Grade 1 (N=14)
Every teacher described a positive impact. Most said it had affected the children's writing and their desire to write. Children "were more interested in writing", "were more enthusiastic about writing", "thought of writing as fun", and "did more writing".

Some said it made the children more "print aware"; others described the microcomputer as a tool that "added a new dimension to writing". A few spoke of enhancements in the areas of composing, editing, creating, collaborating, and confidence-building. Two said the neat printed product was a "positive reinforcement for students with small muscle control problems". One said it had "created an awareness of spacing and simple punctuation".

One teacher described the negative impact on the classroom of having to send the machine out for repairs four times.

Grade 3 (N=13)
Every teacher described a positive impact. Among the most frequent comments were "more pleasure in writing", "more enthusiasm for writing", "better editing", "longer/more detailed stories", "motivation for reluctant writers", and "increased awareness of academic uses of computers".

Three teachers spoke of students who usually had difficulties with spelling and printing taking great delight in the computer. One teacher said it increased the amount of writing students did in such areas as mathematics and science. And another teacher said the computer made it easier to keep track of students' writing and then to display it or send it home.

However, one teacher was very bitter that the equipment did not run properly at the beginning of the project and, unfortunately, continued to function poorly throughout the study. A second said there was not enough equipment. And a third commented that a few students who had access to computers elsewhere were indifferent to them.

Grade 6 (N=14)
One teacher wrote that the impact had been considerable, ranging from "frustration" to "ecstasy". A second teacher said there had been no impact and that "the machines were just present and used", and two teachers described frustrations with "mechanical problems".

Notwithstanding the above, thirteen teachers described the impact of the microcomputers in their classrooms in such positive terms as "more interest and effort in writing", "more enjoyment of writing", "excellent", "easier and better editing", "longer stories", "better/more descriptive stories", and "more student interaction".

Two teachers described how students had gradually changed from just transcribing their own writing to writing an original draft on the computer. One spoke of the pride students took in recopying, rereading, and then printing out a good published copy. One said it freed students from worrying about mechanics and let them concentrate on creating. And another said it made writing "relevant and important".

2. What Strategies Have Proven Successful for Incorporating Microcomputers into Your Writing Program?

Strategies mentioned most frequently are listed first. Those that are listed were each given by more than one teacher and begin with the most frequently mentioned.

Grade 1 (N=18)
- Work with classmates/older students;
- Rotate students on computer throughout the day;
- Set computer up as an activity centre/allow students to use it when they want/do not pressure them/free play experimentation;
- Put printed stories together as a "published" book;
- Load the computer in advance;
- Print the original before editing;
- Give the students a "licence" when they have learned the mechanics; if they misuse the computer, revoke it;
- Learn the keyboard by copying prewritten material, names, etc.;
- Write stories directly on the computer.

Grade 3 (N=13)
- Schedules of various kinds;
- Pairs/partners/collaboration/share editing;
- TYPEAWAY for teaching keyboarding;
- Use of class "experts"/instruct a few students and let them teach the others;
- Edit and print for each other/put printed stories together as a "published" book;
- Use of the printer;
- Set up as an activity centre;
- Turning over the entire operation and use of the computers to the students.

Grade 6 (N=14)
- Schedules/timetables;
- Use student "experts" or train a few students to assist others and monitor computers;
- Simply make the computers available;
- Be flexible and allow the students to use the computers throughout the day;
- Groups/pairs/buddies;
- Use spares and free time to work on computers.

3. What Strategies Have Proven Unsuccessful for Incorporating Microcomputers into Your Writing Program?

Strategies mentioned most frequently are listed first. Strategies given by just one teacher have not been included.

Grade 1 (N=9)
- Attempting to instruct all the children - better to let an older child or an "expert" child do it;
- Allowing too much time for non-English speaking children - they simply type letters randomly or copy;
- Limiting use to "writing times".

Grade 3 (N=10)
- Limiting use to "writing times".

Grade 6 (N=8)
- Completely unsupervised time on the computer - some students will dominate, and others may never try.

4. How Appropriate are Microcomputers for Writing at Your Grade Level?

Grade 1 (N=14)
Ten teachers answered "very appropriate" to this question. Of these ten, two commented as follows:

> For many young children whose fine motor skills are not fully developed, the computer has been invaluable as a writing tool. Many of these children previously would not have written at all in Senior Kindergarten or Grade 1. The speed with which results were achieved is significant.
>
> The children approached the computer confidently, were willing to take risks, and enjoyed "the ease of writing".

Other teachers commented on the eagerness of the children and how quickly they adjusted to the computer. One teacher said that Grade 1 children are capable of performing all the functions of STORY WRITER.

Of the other four teachers, one said the appropriateness "depended on having more computers", a second said it was appropriate "after the children had gained a command of phonics and word attack skills", a third said it would be more appropriate "if graphics were incorporated", and the fourth said "don't know" but added:

> It certainly has a place in the writing program. I think it helped some 'slower' children to develop a sense of pride and ownership in their stories. It helped the 'brighter' ones to really expand. I think it helped some with spelling, word structures, and sequencing patterns.

Grade 3 (N=13)
All of these teachers reported that computers are appropriate for writing at the Grade 3 level. Here are a sample of their comments.

> They are appropriate. Children love to have control over a machine. There was never a request for games or video type programs.
>
> Very appropriate. Many of my children are writing lengthy stories (10 pages +) and are able to do so much more quickly. Corrections are also easier - I would never insist that these children rewrite such lengthy stories. The published stories are a real motivation for others to write.
>
> Fantastic!
>
> I did not think there would be a significant change, but much to my surprise the computers have had a very beneficial effect. It has taken the pressure of pencil/paper work off the children.
>
> I conclude "very appropriate" since all of the kids took to them like ducks to water.
>
> Extremely appropriate for primary students, but STUDENT WRITER does not function properly because stories "disappear".
>
> Most appropriate, however typing skills are a must.

> Totally appropriate, however it is difficult at the beginning as children need constant help and demand instant attention when confronted with difficulties. Once QWERTY is reasonably mastered, stories are written much more quickly and errors are easier to spot by both students and teachers.

Grade 6 (N=14)
Thirteen of these teachers offered positive comments about the appropriateness of computers for writing at the Grade 6 level. The other teacher felt the question was "confusing". Again, a sample of the comments is informative:

> Excellent! When they learn the basics it provides an easy way to concentrate on the composing and editing process.
>
> I feel that computers greatly aid the writing process. The only limitation has been pupils' access to the computers. Two computers are helpful but five would allow more time.
>
> Super! They can be employed quite easily.
>
> They should be introduced at a lower level and should be familiar tools by Grade 6.
>
> Excellent! Mainly because the pupils were from French Immersion.
>
> Very appropriate. At the Grade 6 level, students are aware of grammar and spelling rules and like to have a polished final copy. Editing is so easy for them on the computer. Saving work on discs is very useful - over a period of days or weeks, they write much longer pieces.

5. What Kinds of Support Systems do Teachers Need for Successful Incorporation of Microcomputers Into Writing Projects?

Grades 1, 3, and 6 (N=41)
All responses are recorded here with numbers of teachers associated with each.
- Good in-service on all aspects of the computer and on its incorporation into the curriculum (21);
- Technical help that is good, available, and fast (14);

- Access to resource personnel/consultants (8);
- Materials such as paper, power bars, and discs (7);
- More computers (6);
- More software (5);
- Chances to share ideas with other teachers (5);
- Good programs with no "bugs" (4);
- Programs that are more varied and include other language skills (3);
- Better equipment (3);
- A classroom "helper" (3);
- Examples of good strategies (2);
- Help with setting up computers (1);
- Positive reinforcement from administration (1);
- Written handbook related to in-service (1);
- More printers (1);
- Sufficient space (1);
- Hotline (1);
- TYPEAWAY (1);
- Buy from a reputable company (1);
- Computers that work properly (1);
- More time (1);
- Graphics programs (1);
- School lab of computers (1);
- Two keyboards for team writing (1).

6. Do You Want to Continue Using Microcomputers in Your Writing Program? (Elaborate)

Grade 1 (N=14)
All fourteen teachers answered "YES" to this question. The elaborations they provided were very similar to responses to previous questions. The following are a few additional ideas:

- I would like to take the equipment to my new school;
- Yes, I would like to try some new strategies next year;
- Yes, I believe it has had beneficial effects on a variety of writing aspects from spacing words to ease in editing;
- Yes, the computer has a basic appeal to most youngsters and helps them focus on print;
- Yes, definitely. I will begin immediately in September to let children experiment and become familiar with the keyboard, its functions and its limitations. I am sure the results and growth will be much greater next year;
- Yes, each of my children has published four or five books from February through May.

Grade 3 (N=13)
Every teacher said "YES", frequently followed by such comments as:

> There are many other things I would like to try, especially after the children have had more experience on the keyboard.

> The productivity, interest, and improvement in creative writing have made my program much more beneficial.
>
> Yes! Yes! Yes! The computer is a great asset to any classroom.
>
> I can't imagine the writing program without the computers. Was it really only nine months ago that I 'knew nothing' about computers? Now I feel they are an essential element in the program.
>
> Absolutely! I wish I could have one computer per child to avoid fights and jealousy.
>
> I definitely want to continue using microcomputers in my writing program. However, as I have become more proficient and knowledgeable, I have found many other uses for delivery of curriculum and could use three or four times as many terminals. It has also helped me with daily plans, record keeping, report writing, etc., etc., etc. I need the computer to survive.
>
> Most definitely. They have been wonderful this year. First, in making the children computer literate; second, in making the children familiar with the keyboard; third, to encourage reluctant writers; fourth, to remove spelling fears; and finally, for the good writers, to enable them to write lengthy stories quickly to match the speed of their thought.

Grade 6 (N=14)

As for Grades 1 and 3, every Grade 6 teacher answered "YES". Consider the following additional remarks:

> The computer has become an integral part of my writing program.
>
> There should be at least five computers in each class along with printers and disc drives. I feel very strongly that students should have far more time on computers than they are now getting.

Most definitely. The experience this year has been very positive. My students enjoy using the computer and helping one another at the computer.

They have helped to improve the quality and amount of writing for the six months we've had them.

Yes, but get the bugs out of STUDENT WRITER. Improve the printing options, include a voice read out and specific class/student checks to the assistant speller.

7. What Recommendations Would You Make to a Teacher Who is Just Beginning to Use Microcomputers For a Writing Program?

Grade 1 (N=14)

A long list of recommendations was provided by Grade 1 teachers. Those that are listed were each given by more than one teacher and begin with the most frequently mentioned.

- Have a thorough knowledge of hardware and software/ Be computer literate/Take a course or participate in good in-service;
- Give the children freedom, a chance to explore, time to experiment/Don't rush them;
- Be familiar with Donald Graves's approach to teaching writing;
- Enjoy the experience with kids/Relax and let them go to it;
- Have the children work in pairs or small groups, especially at the beginning;
- Allow equal time on computers for all students;
- Use the computer all day;
- Train the students to load, print, save, and edit - they can do it;
- Publish immediately and share it;
- Put computers in a quiet, private location;
- Experiment with strategies and do what is best and feels comfortable.

Grade 3 (N=13)

Two or more teachers made each of the following recommendations in order of frequency of mention:

- Train a few students first on the basics and mechanics and then let them train the others.
- Be computer literate/Know basics/Get some in-service.
- Schedule for equal student time on computers.
- Leave the entire operation of the computers up to the students.
- Have another adult in the school who is knowledgeable/ Teach across the hall from an expert.

One teacher proposed the following as a year's program for introducing Grade 3 students to writing with computers:

September to January	- Introduce computer parts and vocabulary. - Introduce and use TYPEAWAY, it is excellent. - Use drill type exercises to practise numerals, letters, and cursor. - Begin words and phrases.
January to June	- Use word processing programs, beginning with STORY WRITER, then moving to STUDENT WRITER.

Grade 6 (N=14)

Similarly, the Grade 6 teachers recommended:

- Be computer literate/Know the basics/Go to workshops or in-service;
- Preview programs/Be sure programs fit the writing curriculum;
- Be flexible and let the students experiment;
- Use TYPEAWAY;
- Use student "experts" to help the others or train a few for this purpose;
- Pair the students;
- Show them how to use it and then let them do it; don't meddle;
- Schedule for equal student use;
- Have good equipment with colour and sound;
- Put control commands on cards for easy reference;
- Have someone in the school who can deal with technical problems;
- Compose directly into the computer.

SUMMARY AND DISCUSSION

The purpose of this study was to investigate the effects of microcomputers on the writing of elementary pupils. The pupils involved were in Grades 1, 3, and 6. The dimensions investigated were "writing products", "attitudes", "process", and "roles".

Data were collected through standardized tests, collection of writing samples, attitude scales, interview schedules, observation schedules, and questionnaires. Data were collected for both experimental pupils using microcomputers and comparison pupils using traditional tools. The findings were remarkably stable and consistent regardless of how the data were collected, but quite different for the three grade levels.

What follows is a summary and discussion of the findings for each grade level organized according to the four dimensions - products, attitudes, process, and roles.

Grade 1

a) Products

During the prephase of the study, all the pupils wrote with traditional tools. However, the experimental pupils were writing fewer words, were not writing as well, and were not reading as well as the comparison pupils.

In January, one microcomputer was placed in each of the experimental classrooms. By June, the experimental pupils had either caught up to the comparison pupils or, on most measures, had surpassed them. The experimental pupils were writing much more on the computers; the average number of words per piece of writing was 44; the comparison group averaged 30 words. When assessed holistically, the experimental pupils were writing better. When evaluated analytically, they wrote better in terms of "ideas", "organization", "syntax", and "spelling". On the subscale of "punctuation/capitalization", they had caught up to the comparison group. The experimental pupils were also writing more with traditional tools than the comparison pupils and, had matched them on quality. By June, the experimental pupils had statistically caught up to the comparison children in reading.

b) Attitudes

The experimental and comparison pupils' attitudes toward writing remained much the same through all phases of the study. However, when the experimental pupils were asked particularly about the computers as well as the writing they did on them, many reported they liked the computers, felt the computers were easy to use, and felt their writing was better on the computers. Teachers also spoke of the

positive reactions of the children to the computers and, on a 1-10 scale, rated the effects of the computers on their writing as 7.3.

The experimental and comparison teachers' attitudes toward teaching writing remained much the same throughout all phases of the study. Although, with computers, the experimental teachers were more likely to reassess their methods for teaching writing.

c) Process

The experimental children operated the computers and used the software in a very simple way. They mostly used the keyboard with one hand and one finger. Revision usually took the form of character by character deletion.

At the Grade 1 level, the process of writing with computers and writing with traditional tools had one outstanding difference. Writing with traditional tools nearly always included drawing a picture, an activity that was not possible when experimental children wrote with computers. In addition, when writing with computers, the data suggest that Grade 1 children do more composing, dictate to the teacher more often, and do less copying from other sources.

According to reports from the pupils and teachers, both groups read their writing to themselves and others, and revised words and spelling in much the same way. However, the observational data suggest that more reading and more revising was taking place when the experimental pupils wrote with computers than when the comparison pupils wrote with traditional tools.

d) Roles

The microcomputer in each Grade 1 classroom was usually established as an activity centre. It did not dramatically change pupil-pupil roles, pupil-teacher roles, or the classroom environment. However, a few differences did come to light.

Given the number and set-up of the microcomputers for this study, there seemed to be less teacher-pupil and pupil-pupil interaction when a pupil wrote using a computer than when a pupil wrote with traditional tools. For both groups, the nature and purpose of the interaction was basically the same, with one major exception. In the experimental group, both teachers and pupils were likely to interact for the purpose of demonstrating mechanical and technical matters.

The data also suggest that the experimental teachers were less likely to "lecture" with computers than without, and also more likely to engage in "one-to-one conferencing" to help pupils improve the weaknesses in their writing. Teachers with computers were not playing the role of "challenger" as often as teachers without computers.

Grade 3

a) Products

During the prephase of the study, the experimental pupils were writing fewer words and were not writing as well. In January, one or two microcomputers were placed in the experimental classrooms. After approximately six months, the experimental pupils had either caught up to the comparison pupils or, on some measures, had surpassed them. The experimental pupils had increased the average length of their pieces of writing by 76 words, while the comparison children had increased the average length of their pieces of writing by 25 words. When assessed holistically, the experimental pupils were writing as well on computers as the comparison pupils were with traditional tools. When assessed analytically, the experimental pupils were writing better in terms of "ideas", "usage/word choice", "punctuation/capitalization", and "spelling". After experience with the microcomputers, the experimental pupils had caught up to the comparison pupils in terms of quantity written with traditional tools, but still remained behind in terms of quality of writing.

In June, the experimental teachers were more likely than comparison teachers to say pupils had improved in their writing during the year.

Reading scores of the experimental and comparison pupils remained statistically equal through all phases of the study.

b) Attitudes

The experimental and comparison pupils' attitudes toward writing remained much the same throughout all phases of the study. However, when the experimental pupils were asked particularly about the computers as well as the writing they did on them, many reported they liked the computers, felt the computers were easy to use, felt they were fun, and felt their writing was better on the computers. Teachers also spoke of the positive reactions of the children to the computers and, on a 1-10 scale, rated the effects of the computers on their writing as 7.8.

The experimental and comparison teachers' attitudes toward teaching writing remained much the same throughout all phases of the study.

c) Process

The experimental children operated the computer and used the software in an unsophisticated manner. Many used the keyboard with one hand and one finger. Revisions usually took the form of character by character deletion. The majority were loading, saving, and printing.

At the Grade 3 level, the process of writing with computers and writing with traditional tools had one major difference. Writing with traditional tools frequently involved drawing a picture, an activity that was not possible when experimental children wrote with computers. When writing with computers, the Grade 3 children were more interested/motivated, engaged in more on-task behaviour, did more revisions, and did more composing than children who write with traditional tools. Several other changes also occurred in the classrooms with computers: (1) Teachers were less likely to control the writing activities of their pupils; (2) Pupils were more likely to control their own writing activities; (3) Teachers were less likely to facilitate the writing process; (4) Teachers engaged in more one-to-one conferencing to improve weaknesses in the children's writing; (5) Teachers were more likely to acknowledge pupils' writing by having them share it with other pupils; and (6) Teachers were more likely to acknowledge pupils' writing by having them read it to the teachers.

According to reports from the pupils, teachers, and researchers, both groups read their writing to themselves and others, and revised words and spelling in much the same way.

d) Roles

One or two microcomputers in a Grade 3 classroom were usually set up as an activity centre and did not dramatically change pupil-pupil roles, pupil-teacher roles, or the classroom environment. However, a few differences did surface.

The data suggest there may be less pupil and teacher interaction when a pupil writes on a computer than when he/she writes with traditional tools. When interaction does occur, there is a strong possibility that the focus will be on mechanical and technical matters. On the part of peers, there is less "facilitating", "challenging", "motivating", and "distracting". On the part of the teachers, there is less "challenging", "modelling", and "arbitrating".

Grade 6

a) Products

The introduction of two or three microcomputers into a Grade 6 classroom for six months has minimal, if any, effect on quality of writing, quantity of writing, and reading. When the pieces of writing were evaluated analytically, writing done on the computers was rated higher than writing done with traditional tools in terms of "syntax", "usage/word choice", and "spelling". No other indications of change were found.

b) Attitudes

The experimental and comparison pupils' attitudes toward writing remained much the same through all phases of the study. However, at the end of the study, the experimental children reported that writing was "less difficult" than did the comparison children, while the latter reported that writing was "more useful" and had "more positive attitudes towards reading" than did the former.

When the experimental pupils were asked particularly about the computers as well as the writing they did on them, they were not as enthusiastic as the Grades 1 and 3 pupils. Indeed, 67% reported that their writing was the same as that done with traditional tools. Many reported that they were transcribing the writing they had done on paper onto the computer. On a scale of 1-10, teachers rated the effects of the computers on Grade 6 pupils' writing as 6.9 - this was lower than for Grades 1 and 3.

The experimental and comparison teachers' attitudes toward teaching writing remained much the same through all phases of the study.

c) Process

The experimental children operated the computers and used the software in a somewhat more sophisticated manner than did the Grades 1 and 3 children. Many used the keyboard with both hands and several fingers, but none were touch typing. Revisions usually took the form of character by character deletion and insertion. The majority were loading, saving, and printing.

Several changes occurred in the classrooms with microcomputers: (1) Teachers engaged in more one-to-one conferencing to improve weaknesses in the children's writing; (2) Teachers were more likely to acknowledge pupils' writing by having them share it with other pupils; and (3) Teachers were more likely to acknowledge pupils' writing by having them read it to the teachers.

When writing with computers, the data suggest that Grade 6 children may be more interested/motivated, engage in more on-task behaviour, do more revision, and read their writing more often than children who write with traditional tools. However, Grade 6 experimental children spent quite a bit of time transcribing paper writing onto the computer while the comparison children spent quite a bit of time drawing pictures. Experimental children were less likely than comparison children to work with previously saved material and to copy words from another source.

Grade 6 pupils of both groups did not read their writing to themselves or others as much as the Grades 1 and 3 pupils. Grade 6 experimental and comparison children were revising their writing according to similar patterns.

d) Roles

Two or three microcomputers in a Grade 6 classroom did not dramatically change pupil-teacher roles, pupil-pupil roles, or the classroom environment. However, some changes in pupil and teacher roles were detected.

The data suggest that teacher-pupil interaction at the computer is quite limited. With computers in the classroom, teachers were less likely to report their role as "experts", "challengers", "models", "lecturers", or even "arbitrators". They said the interaction was frequently to demonstrate or facilitate mechanical and technical details. They rated "quality of teacher interaction" lower than did the comparison teachers.

Pupil-pupil interaction also tended to focus on mechanical and technical details in the experimental group. The comparison pupils may have been collaborating more with an academic focus, challenging and motivating each other more. The comparison pupils may also have been distracting each other more with interaction that had a social focus.

In conclusion, the findings of this study have demonstrated that elementary children, particularly those in the primary grades, write more and write better with microcomputers than they do with traditional tools. Such results can be obtained in a regular classroom environment with very few microcomputers and within six months. The study has also demonstrated that the process of writing with microcomputers is different in several respects. It is different from the process of writing with traditional tools and it differs by grade level. Finally, various aspects of the study suggest that the use of microcomputers for teaching writing in the elementary grades is compatible with the philosophy of teaching writing encouraged by the Ontario Ministry of Education and the Language Study Centre of the Toronto Board of Education.

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APPENDIX A

QUANTITY OF WRITING

ADDITIONAL INFORMATION AND STATISTICS

QUANTITY OF WRITING

Quantity of writing was measured by counting the numbers of words in each piece of writing. To do this, it was necessary to define "a piece of writing" and "a word". "A piece of writing" was anything that was not a poem, a book report, work exercises, copied material, underwriting, and responses to dittoed questions. A group of letters was defined as "a word" if it had a space before and after and was intelligible. Words that were spelled inventively but were still intelligible were accepted. Students' names and dates of composition were not counted as words.

The pieces of writing that were analysed were only those which the students voluntarily placed in their writing folders and which also satisfied the above definitions. A total of 3,097 pieces of writing were analysed. The numbers of pieces broken down by group and grade are as follows:

Experimental Groups

Grade	Prephase Paper	Postphase Paper	Computer
1	380	93	301
3	264	136	117
6	150	87	108
	794	316	526

Comparison Groups

Grade	Prephase Paper	Postphase Paper
1	319	362
3	220	231
6	170	159
	709	752

As described in the main text, word averages per child, per grade, and per group were calculated and submitted to statistical analyses.

Not every child placed writing in his/her writing folder during every phase of the study; a few children submitted writing that did not fit the definition; a few children moved away before the study was completed; and a few did not use the software properly. These various factors meant that the numbers of children varied from one statistical test to another.

Tables A1, A2, and A3 outline the statistical calculations for each grade level.

TABLE A1

Quantity of Writing: GRADE 1 STATISTICS*

Writing Samples	N	Mean Number of Words	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test** F	Covariate Test** Prob GT F
Experimental prephase	22	7.99	13.28				
Comparison prephase	27	12.02	11.74	1.28	0.5475		
Experimental postphase; computer writing	22	44.38	26.73				
Comparison postphase; paper writing	27	30.31	25.16	1.13	0.7606	11.70	0.0013
Experimental prephase	26	6.46	12.54				
Comparison prephase	27	12.02	11.74	1.14	0.7416		
Experimental postphase; paper writing	26	35.41	88.16				
Comparison postphase; paper writing	27	30.31	25.16	12.28	0.0001	9.26	0.0037

* N's and means vary on the same groups because not all children provided samples of writing for every phase.

** Differences between postaverages were tested controlling for preaverages.

TABLE A2

Quantity of Writing: GRADE 3 STATISTICS*

Writing Samples	N	Mean Number of Words	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test** F	Covariate Test** Prob GT F
Experimental prephase	25	92.01	63.96				
Comparison prephase	28	118.90	152.26	5.67	0.0001		
Experimental postphase; computer writing	25	168.34	134.11				
Comparison postphase; paper writing	28	144.26	101.81	1.74	0.1669	1.01	0.3190
Experimental prephase	23	82.84	64.39				
Comparison prephase	28	118.90	152.26	5.59	0.0001		
Experimental postphase; paper writing	23	145.74	133.00				
Comparison postphase; paper writing	28	144.26	101.81	1.71	0.1866	0.32	0.5746

* N's and means vary on the same groups because not all children provided samples of writing for every phase.

** Differences between postaverages were tested controlling for preaverages.

TABLE A3

Quantity of Writing: GRADE 6 STATISTICS*

Writing Samples		Mean Number of Words	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test** F	Covariate Test** Prob GT F
Experimental prephase	24	235.01	144.99				
Comparison prephase	29	231.85	154.19	1.13	0.7699		
Experimental postphase; computer writing	24	238.08	148.00				
Comparison postphase; paper writing	29	319.31	202.95	1.88	0.1260	2.83	0.0986
Experimental prephase	21	226.49	140.67				
Comparison prephase	29	231.85	154.19	1.20	0.6795		
Experimental postphase; paper writing	21	224.11	145.91				
Comparison postphase; paper writing	29	319.31	202.95	1.93	0.1302	3.45	0.0693

* N's and means vary on the same groups because not all children provided samples of writing for every phase.

** Differences between postaverages were tested controlling for preaverages.

TABLE A4

Quantity of Writing During Ten Minute Interval in May

Writing Samples	N	Mean Number of Words	Standard Deviation	t-Test F	t-Test Prob GT F
Grade 1 experimental; computer writing	27	12.15	8.09		
Grade 1 comparison; paper writing	27	5.41	5.51	2.16	0.0550
Grade 3 experimental; computer writing	29	38.21	36.05		
Grade 3 comparison; paper writing	27	24.07	20.70	3.03	0.0057
Grade 6 experimental; computer writing	29	48.48	21.76		
Grade 6 comparison; paper writing	28	33.89	26.46	1.48	0.3100

APPENDIX B
QUALITY OF WRITING

ADDITIONAL INFORMATION AND STATISTICS

QUALITY OF WRITING

Quality of writing was evaluated using both holistic and analytic methods.

Holistic Evaluation

The same 3,097 pieces of writing that were analysed for "quantity of writing" (see Appendix A) were also holistically evaluated for "quality of writing".

Both research assistants holistically evaluated all pieces according to the following steps (pupil names and dates on the pieces of writing were masked):

(1) Both assistants independently divided all writing for each grade into three piles, rated on a 1 to 10 scale into HIGH, MEDIUM, LOW as follows:

LOW	MEDIUM	HIGH
1-3	4-7	8-10

(2) Both assistants then independently chose a few pieces from each pile that they considered to have ratings of "1", "4", "7", and "10".

(3) The assistants discussed their choices in (2) above and negotiated until they agreed on four pieces that could be used as anchor points with ratings of "1", "4", "7", and "10", for each grade.

(4) All pieces of writing at each grade level were then placed back together in random order.

(5) Each assistant then independently used the anchor points to holistically evaluate every piece of writing on a 1 to 10 scale.

(6) Two average scores (based on the ratings of each assistant) were then calculated for each pupil for all pieces of writing for each of the three phases of the study.

(7) Pearson product moment correlation coefficients were calculated on the average scores in (6) to estimate interrater reliabilities at each grade level for each phase of the study. They indicated excellent correlations as follows:

	Reliability		
	Grade 1	Grade 3	Grade 6
Prephase paper	0.96	0.81	0.95
Postphase paper	0.94	0.87	0.91
Postphase computer	0.92	0.84	0.96

The details of the statistical analyses are provided in Tables B1, B2, and B3.

Analytic Evaluation

Analytic evaluation was also used to rate the "quality of writing" for 25% of all the pieces of writing the children voluntarily placed in their folders. The numbers of pieces analysed at each grade level for each phase of the study are as follows:

	Number of Pieces		
	Grade 1	Grade 3	Grade 6
Prephase paper	110	110	104
Postphase paper	106	102	98
Postphase computer	42	50	46

One research assistant and a new person specifically hired for the analytic evaluation proceeded according to the following steps:

(1) The evaluators randomly selected two pieces of writing for each child for each phase of the study. (In 3% of the cases, just one piece of writing was available; the scores on these pieces were used twice.)

(2) The evaluators selected additional pieces of writing at each grade level and used these to independently practise the analytic evaluation and to work out differences they had in interpreting the scoring guides (see Figures B1, B2, and B3).

(3) Together, they worked out differences they had in interpreting the scoring guides until a reasonable level of agreement had been reached.

(4) Using the scoring guides, the evaluators then independently scored each piece of randomly selected writing.

The analytic guides for each grade were adapted from Prater and Padia (1983). In using the guides, the evaluators experienced most success with the three scales "Ideas", "Punctuation/Capitalization", and "Spelling". They found the other three scales, "Organization", "Syntax", and "Usage/Word Choice" not as easy to apply in the evaluation of writing done by elementary school children. These differences are reflected in some of the Pearson product moment correlations used to calculate the interrater reliabilities. The reliabilities are as follows:

	Reliability		
	Grade 1	Grade 3	Grade 6
Ideas	0.81	0.74	0.44*
Organization	0.79	0.59	0.49
Syntax	0.68	0.58	0.43
Usage/Word Choice	-	0.44	0.53
Punctuation/ Capitalization	0.66	0.66	0.58*
Spelling	0.84	0.70	0.60*

Reliabilities marked with an "*" are somewhat low because scores in these cases tended to fall at the upper levels of the scales, that is, distribution of scores was skewed for both raters.

For statistical analyses, the ratings given by each evaluation to each pupil's two pieces of writing were added (for each phase of the study) and then averaged for the two evaluators. Details of the statistical analyses are shown in Tables B4-B9; the scores on a scale of 2 to 6.

TABLE B1

QUALITY OF WRITING - HOLISTIC MARKING: GRADE 1 STATISTICS*

(SCALE OF 1-10)

Writing Samples	N	Mean Rating	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test** F	Covariate Test** Prob GT F
Experimental prephase	21	2.80	0.96				
Comparison prephase	27	4.14	1.87	3.80	0.0033		
Experimental postphase; computer writing	21	6.31	1.51				
Comparison postphase; paper writing	27	5.63	2.11	1.95	0.1299	38.35	0.0001
Experimental prephase	26	2.40	1.03				
Comparison prephase	27	4.14	1.87	3.31	0.0037		
Experimental postphase; paper writing	26	4.51	1.61				
Comparison postphase; paper writing	27	5.63	2.11	1.71	0.1824	3.73	0.0592

* N's and means vary on the same groups because not all children provided samples of writing for every phase.

** Differences between postaverages were tested controlling for preaverages.

TABLE B2

QUALITY OF WRITING - HOLISTIC MARKING: GRADE 3 STATISTICS*

(SCALE 1-10)

Writing Samples	N	Mean Rating	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test** F	Covariate Test** Prob GT F
Experimental prephase	25	5.07	1.57				
Comparison prephase	28	5.70	1.01	2.44	0.0269		
Experimental postphase; computer writing	25	6.25	1.38				
Comparison postphase; paper writing	28	6.38	0.93	2.18	0.0521	0.86	0.3586
Experimental prephase	23	4.68	1.53				
Comparison prephase	28	5.70	1.01	2.30	0.0415		
Experimental postphase; paper writing	23	5.55	1.49				
Comparison postphase; paper writing	28	6.38	0.93	2.55	0.0218	0.30	0.5847

* N's and means vary on the same groups because not all children provided samples of writing for every phase.

** Differences between postaverages were tested controlling for preaverages.

TABLE B3

QUALITY OF WRITING - HOLISTIC MARKING: GRADE 6 STATISTICS*

(SCALE 1-10)

Writing Samples	N	Mean Rating	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test** F	Covariate Test** Prob GT F
Experimental prephase	24	5.74	1.89				
Comparison prephase	29	6.40	1.31	2.08	0.0663		
Experimental postphase; computer writing	24	6.54	1.30				
Comparison postphase; paper writing	29	6.71	1.56	1.44	0.3796	0.44	0.5082
Experimental prephase	20	5.46	2.11				
Comparison prephase	29	6.40	1.31	2.59	0.0219		
Experimental postphase; paper writing	20	5.84	1.77				
Comparison postphase; paper writing	29	6.71	1.56	1.29	0.5315	0.32	0.5750

* N's and means vary on the same groups because not all children provided samples of writing for every phase.

** Differences between postaverages were tested controlling for preaverages.

TABLE B4

QUALITY OF WRITING - ANALYTIC MARKING: GRADE 1 STATISTICS

PAPER VS. COMPUTER

Analytic Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Ideas							
Experimental prephase	21	2.74	0.64				
Comparison prephase	27	3.31	1.08	2.83	0.0199		
Experimental postphase	21	4.43	0.97				
Comparison postphase	27	3.94	1.03	1.14	0.7703	17.27	0.0001
Organization							
Experimental prephase	21	2.14	0.28				
Comparison prephase	27	2.83	1.08	14.93	0.0001		
Experimental postphase	21	3.60	1.06				
Comparison postphase	27	3.31	1.23	1.35	0.4985	10.40	0.0023
Syntax							
Experimental prephase	21	2.52	0.68				
Comparison prephase	27	3.26	1.13	2.76	0.0228		
Experimental postphase	21	4.07	1.05				
Comparison postphase	27	3.91	1.20	1.30	0.5483	6.20	0.0165

Punctuation/Capitalization							
Experimental prephase	21	2.21	0.34				
Comparison prephase	27	2.76	0.95	7.97	0.0001		
Experimental postphase	21	3.14	1.52				
Comparison postphase	27	3.20	1.10	1.89	0.1265	1.06	0.3076
Spelling							
Experimental prephase	21	2.95	1.00				
Comparison prephase	27	3.70	1.32	1.74	0.2073		
Experimental postphase	21	4.33	1.39				
Comparison postphase	27	4.15	1.25	1.24	0.5935	5.94	0.0188

* Differences between postaverages were tested controlling for preaverages.

TABLE B5

Quality of Writing - ANALYTIC MARKING: GRADE 3 STATISTICS

PAPER VS. COMPUTER

Analytic Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Ideas							
Experimental prephase	25	3.74	0.79				
Comparison prephase	28	4.11	0.55	2.07	0.0689		
Experimental postphase	25	4.82	0.83				
Comparison postphase	28	4.48	0.69	1.45	0.3479	4.30	0.0432
Organization							
Experimental prephase	25	3.08	0.96				
Comparison prephase	28	3.39	0.70	1.91	0.1062		
Experimental postphase	25	4.06	1.16				
Comparison postphase	28	3.98	1.01	1.30	0.5019	0.89	0.3496
Syntax							
Experimental prephase	25	3.34	0.92				
Comparison prephase	28	3.43	0.63	2.11	0.0624		
Experimental postphase	25	4.16	0.93				
Comparison postphase	28	4.07	0.81	1.31	0.4899	0.27	0.6045

Usage/Word Choice							
Experimental prephase	25	3.38	0.68				
Comparison prephase	28	3.63	0.54	1.60	0.2351		
Experimental postphase	25	4.42	0.75				
Comparison postphase	28	4.16	0.68	1.20	0.6460	3.89	0.0540
Punctuation/Capitalization							
Experimental prephase	25	3.44	1.16				
Comparison prephase	28	3.52	0.98	1.41	0.3907		
Experimental postphase	25	4.72	1.25				
Comparison postphase	28	4.11	1.14	1.20	0.6423	4.54	0.0381
Spelling							
Experimental prephase	25	3.90	0.96				
Comparison prephase	28	4.25	0.60	2.54	0.0207		
Experimental postphase	25	5.20	0.89				
Comparison postphase	28	4.59	0.77	1.33	0.4670	13.44	0.0006

* Differences between postaverages were tested controlling for preaverages.

TABLE B6

QUALITY OF WRITING - ANALYTIC MARKING: GRADE 6 STATISTICS

PAPER VS. COMPUTER

Analytic Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Ideas							
Experimental prephase	24	4.17	0.78				
Comparison prephase	29	4.33	0.59	1.75	0.1599		
Experimental postphase	24	4.60	0.55				
Comparison postphase	29	4.69	0.87	2.49	0.0285	0.03	0.8660
Organization							
Experimental prephase	24	3.69	0.75				
Comparison prephase	29	4.14	0.90	1.43	0.3858		
Experimental postphase	24	4.23	0.94				
Comparison postphase	29	4.43	0.94	1.00	0.9830	0.08	0.7786
Syntax							
Experimental prephase	24	3.65	0.95				
Comparison prephase	29	4.03	0.93	1.03	0.9271		
Experimental postphase	24	4.44	0.99				
Comparison postphase	29	4.26	1.17	1.39	0.4247	5.65	0.0213

Usage/Word Choice							
Experimental prephase	24	3.54	0.78				
Comparison prephase	29	3.84	0.73	1.13	0.7525		
Experimental postphase	24	4.56	0.95				
Comparison postphase	29	4.26	1.06	1.25	0.5962	5.58	0.0221
Punctuation/Capitalization							
Experimental prephase	24	4.04	1.04				
Comparison prephase	29	4.45	1.14	1.19	0.6750		
Experimental postphase	24	5.08	1.10				
Comparison postphase	29	4.95	1.06	1.07	0.8562	3.44	0.0694
Spelling							
Experimental prephase	24	4.50	0.99				
Comparison prephase	29	4.93	0.94	1.10	0.7991		
Experimental postphase	24	5.50	0.72				
Comparison postphase	29	5.22	0.85	1.39	0.4245	7.54	0.0083

* Differences between postaverages were tested controlling for preaverages.

TABLE B7

QUALITY OF WRITING - ANALYTIC MARKING: GRADE 1 STATISTICS

PAPER VS. PAPER

Analytic Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Ideas							
Experimental prephase	26	2.52	0.59				
Comparison prephase	27	3.31	1.08	3.36	0.0033		
Experimental postphase	26	3.29	1.07				
Comparison postphase	27	3.94	1.03	1.07	0.8552	0.01	0.9435
Organization							
Experimental prephase	26	2.10	0.25				
Comparison prephase	27	2.83	1.08	19.43	0.0001		
Experimental postphase	26	2.67	0.94				
Comparison postphase	27	3.31	1.23	1.71	0.1840	0.09	0.7657
Syntax							
Experimental prephase	26	2.38	0.64				
Comparison prephase	27	3.26	1.13	3.14	0.0055		
Experimental postphase	26	3.21	1.14				
Comparison postphase	27	3.91	1.20	1.11	0.8014	0.05	0.8167

Punctuation/Capitalization							
Experimental prephase	26	2.15	0.31				
Comparison prephase	27	2.76	0.95	9.55	0.0001		
Experimental postphase	26	2.44	0.55				
Comparison postphase	27	3.20	1.10	3.97	0.0009	1.95	0.1686
Spelling							
Experimental prephase	26	2.71	0.97				
Comparison prephase	27	3.70	1.32	1.84	0.1318		
Experimental postphase	26	3.42	1.25				
Comparison postphase	27	4.15	1.25	1.00	1.0000	0.01	0.9157

* Differences between postaverages were tested controlling for preaverages.

TABLE 88

QUALITY OF WRITING - ANALYTIC MARKING: GRADE 3 STATISTICS

PAPER VS. PAPER

Analytic Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Ideas							
Experimental prephase	23	3.67	0.83				
Comparison prephase	28	4.11	0.55	2.30	0.0414		
Experimental postphase	23	4.33	0.87				
Comparison postphase	28	4.48	0.69	1.62	0.2335	0.06	0.8069
Organization							
Experimental prephase	23	3.00	0.97				
Comparison prephase	28	3.39	0.70	1.91	0.1111		
Experimental postphase	23	3.52	1.10				
Comparison postphase	28	3.98	1.01	1.18	0.6714	0.68	0.4125
Syntax							
Experimental prephase	23	3.13	0.91				
Comparison prephase	28	3.43	0.63	2.05	0.0780		
Experimental postphase	23	3.33	0.91				
Comparison postphase	28	4.07	0.81	1.26	0.5654	7.33	0.0094

Usage/Word Choice							
Experimental prephase	23	3.26	0.60				
Comparison prephase	28	3.63	0.54	1.25	0.5808		
Experimental postphase	23	3.52	0.80				
Comparison postphase	28	4.16	0.68	1.40	0.4077	5.25	0.0263
Punctuation/Capitalization							
Experimental prephase	23	3.28	1.13				
Comparison prephase	28	3.52	0.98	1.33	0.4761		
Experimental postphase	23	3.46	1.28				
Comparison postphase	28	4.11	1.14	1.25	0.5702	3.03	0.0879
Spelling							
Experimental prephase	23	3.70	0.95				
Comparison prephase	28	4.25	0.60	2.50	0.0248		
Experimental postphase	23	3.93	0.88				
Comparison postphase	28	4.59	0.77	1.31	0.4963	2.99	0.0904

* Differences between postaverages were tested controlling for preaverages.

TABLE B9

QUALITY OF WRITING - ANALYTIC MARKING: GRADE 6 STATISTICS

PAPER VS. PAPER

Analytic Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Ideas							
Experimental prephase	20	4.20	0.83				
Comparison prephase	29	4.33	0.59	2.02	0.0891		
Experimental postphase	20	4.18	0.52				
Comparison postphase	29	4.69	0.87	2.80	0.0228	5.05	0.0295
Organization							
Experimental prephase	20	3.63	0.79				
Comparison prephase	29	4.14	0.90	1.28	0.5881		
Experimental postphase	20	3.85	0.84				
Comparison postphase	29	4.43	0.94	1.25	0.6278	1.82	0.1839
Syntax							
Experimental prephase	20	3.48	1.02				
Comparison prephase	29	4.03	0.93	1.19	0.6627		
Experimental postphase	20	3.80	0.68				
Comparison postphase	29	4.26	1.17	2.99	0.0159	0.09	0.7651

Usage/Word Choice							
Experimental prephase	20	3.38	0.76				
Comparison prephase	29	3.84	0.73	1.07	0.8505		
Experimental postphase	20	3.90	0.94				
Comparison postphase	29	4.26	1.06	1.26	0.6024	0.17	0.6803
Punctuation/Capitalization							
Experimental prephase	20	3.83	1.04				
Comparison prephase	29	4.45	1.14	1.19	0.7049		
Experimental postphase	20	4.55	0.96				
Comparison postphase	29	4.95	1.06	1.23	0.6457	0.00	0.9922
Spelling							
Experimental prephase	20	4.43	1.00				
Comparison prephase	29	4.93	0.94	1.13	0.7453		
Experimental postphase	20	4.78	0.87				
Comparison postphase	29	5.22	0.85	1.03	0.9159	0.62	0.4349

* Differences between postaverages were tested controlling for preaverages.

TABLE B10

QUALITY OF WRITING: TEACHERS' RATINGS OF IMPROVEMENT ON A 10-POINT SCALE

Sample and Phase	N	Mean Rating	Standard Deviation	t-Test F	t-Test Prob GT F
Grade 1					
Experimental; prephase	28	5.39	2.35		
Comparison; prephase	29	5.90	1.92	1.50	0.2910
Experimental; postphase	28	6.64	1.73		
Comparison; postphase	29	6.86	1.75	1.02	0.9518
Grade 3					
Experimental; prephase	29	5.59	2.24		
Comparison; prephase	27	4.59	1.91	1.39	0.4062
Experimental; postphase	29	6.72	1.87		
Comparison; postphase	27	5.48	1.16	2.61	0.0160
Grade 6					
Experimental; prephase	28	5.86	1.69		
Comparison; prephase	30	5.90	1.95	1.33	0.4578
Experimental; postphase	28	6.25	1.62		
Comparison; postphase	30	5.87	2.05	1.59	0.2311

Usage/Word Choice							
Experimental prephase	20	3.38	0.76				
Comparison prephase	29	3.84	0.73	1.07	0.8505		
Experimental postphase	20	3.90	0.94				
Comparison postphase	29	4.26	1.06	1.26	0.6024	0.17	0.6803
Punctuation/Capitalization							
Experimental prephase	20	3.83	1.04				
Comparison prephase	29	4.45	1.14	1.19	0.7049		
Experimental postphase	20	4.55	0.96				
Comparison postphase	29	4.95	1.06	1.23	0.6457	0.00	0.9922
Spelling							
Experimental prephase	20	4.43	1.00				
Comparison prephase	29	4.93	0.94	1.13	0.7453		
Experimental postphase	20	4.78	0.87				
Comparison postphase	29	5.22	0.85	1.03	0.9159	0.62	0.4349

* Differences between postaverages were tested controlling for preaverages.

FIGURE B1

ANALYTIC SCORING GUIDE FOR GRADE 1

SCALE	HIGH (3)	MIDDLE (2)	LOW (1)
Ideas	Ideas are insightful, creative original, plausible, or have supporting details. Message is well-communicated.	Reader can decipher an idea(s) or message. However, it is limited in its originality, creativity, or supporting details.	Reader has difficulty deciphering an idea. There is no message.
Organization	The details are organized in a clear fashion to convince reader of a beginning, a middle, and an end. Free of irrelevant details.	Less clear cut organization. Fewer details to support position. Sentences may not always follow logically from previous sentence. May have some irrelevant details.	No visible organizational scheme. Lacks supporting details. There is only one simple sentence.
Syntax	Sentences are clear and unambiguous. No run-ons and few fragments.	Sentences are basically clear. Requires occasional rereading of a sentence. Some run-ons and/or fragments.	Reader has difficulty deciphering meaning of sentences. Many run-ons and/or fragments. Words and sentence parts are omitted.
Punctuation/ Capitalization	Begins and ends sentences correctly. Capitalizes proper nouns and "I". Uses commas in a series. Few, if any errors in punctuation and capitalization.	May occasionally fail to capitalize some proper noun and "I"; may occasionally begin or end sentence incorrectly. Must capitalize first words and use periods, but otherwise may not use them.	Lacks sure knowledge of what to capitalize and punctuate. Inconsistent use of capitals and periods.
Spelling	Spells commonly used words correctly most of the time. When words are misspelled, they very closely approximate correct spelling.	May misspell (more frequently) common words. Some phonetic spelling that can be easily understood.	Many misspellings. Often doesn't approximate correct spelling of word. Writing must be reread to decipher words.

FIGURE B2

ANALYTIC SCORING GUIDE FOR GRADE 3

SCALE	HIGH (3)	MIDDLE (2)	LOW (1)
Ideas	Ideas are insightful, creative, original, plausible, or have supporting details. Message is well-communicated.	Reader can decipher an idea(s) or message. However, it is limited in its originality, creativity, plausibility, or supporting details.	Reader has difficulty deciphering an idea. Any idea(s) that exists lacks insightfulness, creativity, plausibility or supporting details. There is no message.
Organization	The details are organized in a clear fashion to convince reader - a beginning, a middle and an end. Free of irrelevant details. Coherent. Some paragraphing.	Less clear cut organization. Fewer details to support position. Sentences may not always follow logically from previous sentence. May have some irrelevant details.	No visible organizational scheme. Lacks supporting details. Mixes in many irrelevant details. There are only one or two sentences.
Syntax	Sentences are clear and unambiguous. No run-ons, and few, if any, fragments. There is complexity within sentences.	Sentences are basically clear. Requires occasional rereading of a sentence. Some run-ons and/or fragments.	Reader has difficulty deciphering meaning of sentences. Many run-ons and/or fragments. Words and sentence parts are omitted.
Usage/ Word Choice	Generally uses standard English (subject-verb agreement; case and reference of pronouns). Consistent in tense and grammar.	Some errors in standard English (subject-verb agreement; case and reference of pronouns).	Does not use standard English (many errors in subject-verb agreement; case and reference of pronouns).
Punctuation/ Capitalization	Begins and ends sentences correctly, but they include some run-ons. Capitalizes proper nouns and "I". Uses commas in a series.	May occasionally fail to capitalize some proper nouns and "I"; may occasionally begin or end sentences incorrectly.	Lacks sure knowledge of what to capitalize and punctuate.
Spelling	Spells commonly used words correctly almost all the time. When words are misspelled, they closely approximate correct spelling.	May misspell (more frequently) common words. Some phonetic spelling.	Many misspellings. Often doesn't approximate correct spelling of word.

FIGURE B3

ANALYTIC SCORING GUIDE FOR GRADE 6

SCALE	HIGH (3)	MIDDLE (2)	LOW (1)
Ideas	Ideas are insightful, creative, original, plausible, or have supporting details. Message is well-communicated.	Reader can decipher an idea(s) or message. However, it is limited in its originality, creativity, plausibility or supporting details.	Reader has difficulty deciphering an idea. Any idea(s) that exists lacks insightfulness, creativity, plausibility or supporting details. There is no message.
Organization	The details are organized in a clear fashion to convince reader - a beginning, a middle and an end. Free of irrelevant details. Coherency and continuity of thought. Clear paragraphing.	Less clear cut organization. Fewer details to support position. May not place strongest point in prominent position. Sentences may not always follow logically from previous sentence. May have some irrelevant details. Attempt to use paragraphs.	No visible organizational scheme. Lacks supporting details, mixes in many irrelevant details.
Syntax	Sentences are clear and unambiguous. Occasional run-ons, and few, if any, fragments. There is complexity within sentences.	Sentences are basically clear. Requires occasional rereading of a sentence. Some run-ons and/or fragments.	Reader has difficulty deciphering meaning of sentences. Many run-ons and/or fragments. Words and sentence parts are omitted.
Usage/ Word Choice	Generally uses standard English (subject-verb agreement; case and reference of pronouns). Consistent in tense and grammar.	Some errors in standard English (subject-verb agreement; case and reference of pronouns).	Does not use standard English (many errors in subject-verb agreement; case and reference of pronouns).
Punctuation/ Capitalization	Begins and ends sentences correctly, but they include some run-ons. Capitalizes proper nouns and "I". Uses commas in a series. Makes a good attempt at using quotations.	May occasionally fail to capitalize some proper nouns and "I"; may occasionally begin or end sentences incorrectly.	Lacks sure knowledge of what to capitalize and punctuate.
Spelling	Spells commonly used words correctly most of the time. When words are misspelled, they closely approximate the correct spelling.	May misspell (more frequently) common words. Very little phonetic spelling.	Many misspellings. Phonetic spelling that often doesn't approximate the correct spelling of words.

APPENDIX C

READING

STATISTICAL INFORMATION

TABLE C1

GRADE 1 READING STATISTICS: DOLCH SIGHT WORD RECOGNITION

Reading Samples	N	Mean Number Recognized	Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Experimental group; prephase	26	24.54	69.13				
Comparison group; prephase	26	50.54	33.61	4.23	0.0006		
Experimental group; postphase	26	112.46	89.82				
Comparison group; postphase	26	126.27	90.34	1.01	0.9770	0.38	0.5421

* Postphase differences were tested controlling for prephase differences.

TABLE C2

GRADE 3 READING STATISTICS: STANFORD ACHIEVEMENT TEST

Reading Samples	N	Mean Reading Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Experimental group; prephase	28	36.54	9.94				
Comparison group; prephase	25	38.08	9.16	1.18	0.6889		
Experimental group; postphase	28	47.68	14.35				
Comparison group; postphase	25	52.92	14.11	1.03	0.9388	2.08	0.1551

* Postphase differences were tested controlling for prephase differences.

TABLE C3

GRADE 6 READING STATISTICS: STANFORD ACHIEVEMENT TEST

Reading Samples	N	Mean Reading Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Experimental group; prephase	28	36.11	11.19				
Comparison group; prephase	28	42.71	12.49	1.24	0.5738		
Experimental group; postphase	28	41.39	10.42				
Comparison group; postphase	28	46.68	11.19	1.15	0.7135	0.39	0.5353

* Postphase differences were tested controlling for prephase differences.

APPENDIX D

PUPILS' ATTITUDES TOWARDS WRITING

STATISTICAL INFORMATION

TABLE D1

ATTITUDES TOWARD WRITING: GRADE 1 STATISTICS FOR SEVEN SUBSCALES

Attitude Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Enjoyment of Writing							
Experimental; prephase	25	30.00	2.40				
Comparison; prephase	28	28.79	2.88	1.45	0.3632		
Experimental; postphase	25	27.44	4.69				
Comparison; postphase	28	27.21	3.97	1.40	0.3972	0.01	0.9370
Pride in Written Materials							
Experimental; prephase	25	20.72	2.41				
Comparison; prephase	28	20.57	2.30	1.09	0.8147		
Experimental; postphase	25	20.48	2.97				
Comparison; postphase	28	19.50	3.13	1.11	0.8010	1.28	0.2638
Difficulty with Writing							
Experimental; prephase	25	10.40	2.02				
Comparison; prephase	28	9.71	2.34	1.34	0.4722		
Experimental; postphase	25	10.48	1.83				
Comparison; postphase	28	9.50	2.22	1.47	0.3407	1.83	0.1826

Recognition of Good Writing							
Experimental; prephase	25	7.36	1.04				
Comparison; prephase	28	7.50	1.07	1.07	0.8727		
Experimental; postphase	25	7.28	1.17				
Comparison; postphase	28	6.96	1.10	1.13	0.7582	1.56	0.2168
Writing is Useful							
Experimental; prephase	25	4.68	1.03				
Comparison; prephase	28	4.86	0.97	1.13	0.7618		
Experimental; postphase	25	4.60	0.96				
Comparison; postphase	28	4.57	0.96	1.00	0.9976	0.01	0.9247
Collaboration when Writing							
Experimental; prephase	25	2.16	0.90				
Comparison; prephase	28	2.32	0.77	1.35	0.4462		
Experimental; postphase	25	2.08	0.70				
Comparison; postphase	28	2.18	0.55	1.64	0.2125	0.50	0.4841
Attitude Toward Reading							
Experimental; prephase	25	5.28	0.94				
Comparison; prephase	28	5.04	1.23	1.73	0.1784		
Experimental; postphase	25	5.08	0.91				
Comparison; postphase	28	4.96	1.10	1.48	0.3377	0.06	0.8116

* Differences between postmeans were tested controlling for premeans.

TABLE D2

ATTITUDES TOWARD WRITING: GRADE 3 STATISTICS FOR EIGHT SUBSCALES

Attitude Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Enjoyment of Writing							
Experimental; prephase	28	55.89	6.54				
Comparison; prephase	23	50.83	9.20	1.98	0.0930		
Experimental; postphase	28	54.00	6.68				
Comparison; postphase	23	49.09	12.86	3.70	0.0016	1.00	0.3215
Pride in Written Materials							
Experimental; prephase	28	30.61	5.04				
Comparison; prephase	23	29.61	5.59	1.23	0.6051		
Experimental; postphase	28	29.50	4.93				
Comparison; postphase	23	27.78	4.20	1.38	0.4485	1.35	0.2509
Difficulty with Writing							
Experimental; prephase	28	21.07	3.55				
Comparison; prephase	23	20.78	4.87	1.88	0.1182		
Experimental; postphase	28	20.82	3.73				
Comparison; postphase	23	20.65	3.68	1.03	0.9516	0.00	0.9473
Recognition of Good Writing							
Experimental; prephase	28	14.29	2.40				
Comparison; prephase	23	14.61	2.81	1.37	0.4361		
Experimental; postphase	28	14.18	2.70				
Comparison; postphase	23	15.43	8.94	11.01	0.0001	0.40	0.5302

Writing is Useful							
Experimental; prephase	28	15.57	2.97				
Comparison; prephase	23	15.04	2.75	1.17	0.7199		
Experimental; postphase	28	15.07	2.46				
Comparison; postphase	23	14.48	2.83	1.32	0.4929	0.38	0.5422
Collaboration When Writing							
Experimental; prephase	28	2.32	0.98				
Comparison; prephase	23	2.61	0.78	1.58	0.2779		
Experimental; postphase	28	2.61	1.13				
Comparison; postphase	23	2.43	0.90	1.60	0.2633	0.96	0.3310
Attitude Toward Reading							
Experimental; prephase	28	8.75	1.40				
Comparison; prephase	23	8.35	2.06	2.15	0.0602		
Experimental; postphase	28	8.29	1.41				
Comparison; postphase	23	8.43	1.73	1.50	0.3147	0.50	0.4836
Writing Habits							
Experimental; prephase	28	19.21	3.26				
Comparison; prephase	23	19.65	3.31	1.03	0.9268		
Experimental; postphase	28	19.54	3.51				
Comparison; postphase	23	19.17	2.61	1.82	0.1565	0.19	0.6609

* Differences between postmeans were tested controlling for premeans.

TABLE D3

ATTITUDES TOWARD WRITING: GRADE 6 STATISTICS FOR EIGHT SUBSCALES

Attitude Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Enjoyment of Writing							
Experimental; prephase	28	50.39	8.70				
Comparison; prephase	27	52.00	9.68	1.24	0.5855		
Experimental; postphase	28	48.68	9.66				
Comparison; postphase	27	49.19	9.98	1.07	0.8661	0.19	0.6632
Pride in Written Materials							
Experimental; prephase	28	25.68	5.52				
Comparison; prephase	27	27.33	5.39	1.05	0.9031		
Experimental; postphase	28	25.00	5.09				
Comparison; postphase	27	26.74	5.61	1.22	0.6175	0.31	0.5808
Difficulty with Writing							
Experimental; prephase	28	21.32	3.84				
Comparison; prephase	27	21.96	3.73	1.06	0.8800		
Experimental; postphase	28	21.46	3.55				
Comparison; postphase	27	20.41	4.02	1.28	0.5268	4.25	0.0443
Recognition of Good Writing							
Experimental; prephase	28	13.93	2.65				
Comparison; prephase	27	13.81	2.76	1.08	0.8362		
Experimental; postphase	28	14.07	2.64				
Comparison; postphase	27	14.41	2.36	1.25	0.5694	0.44	0.5083

Writing is Useful							
Experimental; prephase	28	14.64	2.82				
Comparison; prephase	27	14.78	2.98	1.12	0.7758		
Experimental; postphase	28	13.25	2.74				
Comparison; postphase	27	14.93	2.83	1.06	0.8762	6.81	0.0118
Collaboration when Writing							
Experimental; prephase	28	2.50	0.96				
Comparison; prephase	27	2.07	0.83	1.35	0.4486		
Experimental; postphase	28	2.64	0.83				
Comparison; postphase	27	2.56	0.80	1.06	0.8749	0.00	0.9684
Attitude Toward Reading							
Experimental; prephase	28	7.54	1.79				
Comparison; prephase	27	8.00	1.64	1.20	0.6498		
Experimental; postphase	28	7.61	1.75				
Comparison; postphase	27	8.59	1.67	1.10	0.8138	4.53	0.0382
Writing Habits							
Experimental; prephase	28	18.61	3.53				
Comparison; prephase	27	19.15	3.11	1.29	0.5193		
Experimental; postphase	28	18.39	3.33				
Comparison; postphase	27	18.89	3.19	1.09	0.8341	0.09	0.7655

* Differences between postmeans were tested controlling for premeans.

APPENDIX E

TEACHERS' ATTITUDES TOWARD TEACHING WRITING

STATISTICAL INFORMATION

TABLE E1

ATTITUDES TOWARD TEACHING WRITING: GRADE 1 STATISTICS FOR NINE SUBSCALES

Attitude Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Enjoyment of Teaching Writing							
Experimental group; prephase	13	34.69	2.93				
Comparison group; prephase	14	36.57	2.21	1.76	0.3275		
Experimental group; postphase	13	35.54	2.96				
Comparison group; postphase	14	35.64	3.37	1.29	0.6645	1.14	0.2963
Pride in Teaching Writing							
Experimental group; prephase	13	8.15	0.69				
Comparison group; prephase	14	8.64	1.08	2.47	0.1279		
Experimental group; postphase	13	8.15	1.07				
Comparison group; postphase	14	8.50	0.76	1.98	0.2370	0.04	0.8438
Difficulty with Teaching Writing							
Experimental group; prephase	13	7.00	1.68				
Comparison group prephase	14	8.43	1.45	1.34	0.6043		
Experimental group; postphase	13	8.08	1.85				
Comparison group; postphase	14	8.86	1.56	1.40	0.5568	0.59	0.4496

Confidence in Teaching Writing							
Experimental group; prephase	13	8.53	0.97				
Comparison group; prephase	14	9.14	0.86	1.25	0.6910		
Experimental group; postphase	13	8.38	0.96				
Comparison group; postphase	14	8.79	1.05	1.20	0.7624	0.30	0.8642
Self-assessment for Improving Methods							
Experimental group; prephase	13	8.54	0.88				
Comparison group; prephase	14	8.86	0.77	1.30	0.6476		
Experimental group; postphase	13	8.69	0.63				
Comparison group; postphase	14	8.21	0.80	1.62	0.4131	4.16	0.0524
Many Sources for Teaching Ideas							
Experimental group; prephase	13	12.15	1.28				
Comparison group; prephase	14	11.64	1.15	1.24	0.7045		
Experimental group; postphase	13	12.31	1.32				
Comparison group; postphase	14	11.57	1.45	1.22	0.7379	0.75	0.3961
Importance of Teaching Writing							
Experimental group; prephase	13	8.00	1.22				
Comparison group; prephase	14	7.86	1.03	1.42	0.5373		
Experimental group; postphase	13	7.62	1.80				
Comparison group; postphase	14	7.86	1.23	2.15	0.1862	0.36	0.5549

(continued overleaf)

TABLE E1 (continued)

ATTITUDES TOWARD TEACHING WRITING: GRADE 1 STATISTICS FOR NINE SUBSCALES

Attitude Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Reading Helps Writing							
Experimental group; prephase	13	4.62	0.51				
Comparison group; prephase	14	4.14	1.23	5.91	0.0041		
Experimental group; postphase	13	4.46	0.52				
Comparison group; postphase	14	4.29	0.91	3.10	0.0586	0.00	0.9843
Writing Tools Affect Writing							
Experimental group; prephase	13	2.92	1.44				
Comparison group; prephase	14	3.57	1.02	2.01	0.2260		
Experimental group; postphase	13	3.31	1.38				
Comparison group; postphase	14	3.14	1.56	1.29	0.6699	0.80	0.3795

* Postphase differences were tested controlling for prephase differences.

TABLE E2

ATTITUDES TOWARD TEACHING WRITING: GRADE 3 STATISTICS FOR NINE SUBSCALES

Attitude Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Enjoyment of Teaching Writing							
Experimental group; prephase	15	34.33	3.35				
Comparison group; prephase	14	33.14	2.96	1.28	0.6574		
Experimental group; postphase	15	34.93	3.95				
Comparison group; postphase	14	32.36	3.56	1.23	0.7142	2.20	0.1499
Pride in Teaching Writing							
Experimental group; prephase	15	7.67	1.68				
Comparison group; prephase	14	7.79	1.05	2.54	0.1013		
Experimental group; postphase	15	8.00	1.41				
Comparison group; postphase	14	7.64	0.63	4.99	0.0063	3.91	0.0587
Difficulty with Teaching Writing							
Experimental group; prephase	15	7.67	2.09				
Comparison group; prephase	14	6.57	1.83	1.31	0.6311		
Experimental group; postphase	15	7.93	1.94				
Comparison group; postphase	14	6.93	2.09	1.16	0.7859	0.19	0.6654

(continued overleaf)

TABLE E2 (continued)

ATTITUDES TOWARD TEACHING WRITING: GRADE 3 STATISTICS FOR NINE SUBSCALES

Attitude Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Confidence in Teaching Writing							
Experimental group; prephase	15	8.33	1.40				
Comparison group; prephase	14	8.29	0.83	2.87	0.0659		
Experimental group; postphase	15	8.33	1.35				
Comparison group; postphase	14	8.64	0.93	2.10	0.1909	1.04	0.3164
Self-Assessment for Improving Methods							
Experimental group; prephase	15	7.80	1.90				
Comparison group; prephase	14	7.93	0.83	5.24	0.0050		
Experimental group; postphase	15	7.93	1.79				
Comparison group; postphase	14	7.71	1.33	1.83	0.2864	0.58	0.4544
Many Sources for Teaching Ideas							
Experimental group; prephase	15	11.67	1.29				
Comparison group; prephase	14	11.14	1.56	1.46	0.4883		
Experimental group; postphase	15	12.00	1.85				
Comparison group; postphase	14	11.50	1.61	1.33	0.6128	0.04	0.8490

Importance of Teaching Writing							
Experimental group; prephase	15	7.53	1.55				
Comparison group; prephase	14	7.43	1.50	1.06	0.9159		
Experimental group; postphase	15	7.60	1.45				
Comparison group; postphase	14	7.07	1.21	1.45	0.5080	1.71	0.2020
Reading Helps Writing							
Experimental group; prephase	15	4.27	0.88				
Comparison group; prephase	14	4.71	0.47	3.55	0.0283		
Experimental group; postphase	15	3.93	1.28				
Comparison group; postphase	14	4.86	0.36	12.42	0.0001	3.97	0.0568
Writing Tools Affect Writing							
Experimental group; prephase	15	3.67	0.98				
Comparison group; prephase	14	3.50	1.09	1.25	0.6805		
Experimental group; postphase	15	3.73	0.80				
Comparison group; postphase	14	3.71	1.07	1.79	0.2921	0.02	0.8969

* Postphase differences were tested controlling for prephase differences.

TABLE E3

ATTITUDES TOWARD TEACHING WRITING: GRADE 6 STATISTICS FOR NINE SUBSCALES

Attitude Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Enjoyment of Teaching Writing							
Experimental group; prephase	15	32.2	2.98				
Comparison group; prephase	14	34.0	4.35	2.13	0.1739		
Experimental group; postphase	15	31.67	4.25				
Comparison group; postphase	14	33.29	3.81	1.25	0.6980	0.02	0.8930
Pride in Teaching Writing							
Experimental group; prephase	15	7.07	1.10				
Comparison group; prephase	14	7.71	1.27	1.33	0.6059		
Experimental group; postphase	15	7.13	1.30				
Comparison group; postphase	14	7.86	1.83	1.98	0.2170	0.04	0.8415
Difficulty with Teaching Writing							
Experimental group; prephase	15	6.40	1.84				
Comparison group; prephase	14	7.50	1.99	1.17	0.7776		
Experimental group; postphase	15	7.20	1.37				
Comparison group; postphase	14	7.14	2.11	2.35	0.1247	0.98	0.3317

Confidence in Teaching Writing							
Experimental group; prephase	15	7.60	1.06				
Comparison group; prephase	14	8.43	1.28	1.48	0.4765		
Experimental group; postphase	15	8.13	1.19				
Comparison group; postphase	14	8.43	1.70	2.04	0.1983	0.53	0.4743
Self-Assessment for Improving Methods							
Experimental group; prephase	15	7.87	0.64				
Comparison group; prephase	14	8.36	1.15	3.23	0.0375		
Experimental group; postphase	15	8.13	0.74				
Comparison group; postphase	14	8.36	1.01	1.84	0.2706	0.11	0.7441
Many Sources for Teaching Ideas							
Experimental group; prephase	15	10.73	2.02				
Comparison group; prephase	14	11.43	1.65	1.49	0.4774		
Experimental group; postphase	15	10.93	1.71				
Comparison group; postphase	14	10.93	1.59	1.15	0.8014	0.32	0.5745
Importance of Teaching Writing							
Experimental group; prephase	15	7.93	1.28				
Comparison group; prephase	14	8.36	1.45	1.28	0.6535		
Experimental group; postphase	15	7.53	1.55				
Comparison group; postphase	14	8.00	1.36	1.31	0.6371	0.22	0.6393

(continued overleaf)

TABLE E3 (continued)

ATTITUDES TOWARD TEACHING WRITING: GRADE 6 STATISTICS FOR NINE SUBSCALES

Attitude Subscale and Sample	N	Mean Total Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Reading Helps Writing							
Experimental group; prephase	15	4.53	0.52				
Comparison group; prephase	14	4.71	0.47	1.21	0.7331		
Experimental group; postphase	15	4.27	0.59				
Comparison group; postphase	14	4.37	1.34	5.07	0.0048	0.06	0.8153
Writing Tools Affect Writing							
Experimental group; prephase	15	3.33	0.72				
Comparison group; prephase	14	3.50	0.65	1.24	0.7060		
Experimental group; postphase	15	3.40	1.18				
Comparison group; postphase	14	3.50	0.76	2.43	0.1192	0.00	0.9656

* Postphase differences were tested controlling for prephase differences.

APPENDIX F

TEACHERS' REPORTS ON WRITING ACTIVITIES AND PROCEDURES

STATISTICAL INFORMATION

TABLE F1

TEACHERS' REPORTS ON WRITING ACTIVITIES AND PROCEDURES: GRADE 1 STATISTICS

Subscale and Sample	N	Mean Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Teacher Control of Writing Activities							
Experimental group; prephase	11	5.32	0.95				
Comparison group; prephase	14	5.06	0.89	1.14	0.8120		
Experimental group; postphase	11	5.02	0.93				
Comparison group; postphase	14	5.33	1.15	1.55	0.4964	2.16	0.1561
Pupil Control of Writing Activities							
Experimental group; prephase	11	7.38	1.57				
Comparison group; prephase	14	7.27	1.22	1.66	0.3896		
Experimental group; postphase	11	7.11	0.90				
Comparison group; postphase	14	6.94	0.85	1.12	0.8272	0.18	0.6797
Teacher-Pupil Collaboration							
Experimental group; prephase	11	7.82	1.29				
Comparison group; prephase	14	7.57	1.85	2.05	0.2591		
Experimental group; postphase	11	7.66	1.42				
Comparison group; postphase	14	7.54	1.37	1.07	0.8847	0.01	0.9287
Pupil Involvement in Evaluation							
Experimental group; prephase	11	7.23	2.13				
Comparison group; prephase	14	6.54	1.88	1.28	0.6603		
Experimental group; postphase	11	7.32	1.57				
Comparison group; postphase	14	6.45	1.89	1.46	0.5555	0.80	0.3812

Whole-class Instruction							
Experimental group; prephase	11	3.36	1.45				
Comparison group; prephase	14	3.29	1.68	1.35	0.6425		
Experimental group; postphase	11	2.89	1.82				
Comparison group; postphase	14	2.63	1.57	1.35	0.6056	0.16	0.6936
Small Group Instruction							
Experimental group; prephase	11	3.95	1.56				
Comparison group; prephase	14	4.14	2.02	1.69	0.4109		
Experimental group; postphase	11	3.09	1.36				
Comparison group; postphase	14	3.54	1.99	2.14	0.2328	0.33	0.5743
Individual Instruction							
Experimental group; prephase	11	8.14	1.47				
Comparison group; prephase	14	8.18	1.87	1.62	0.4514		
Experimental group; postphase	11	8.34	1.22				
Comparison group; postphase	14	8.05	1.32	1.18	0.8013	0.37	0.5490
Teacher as Lecturer							
Experimental group; prephase	11	2.36	1.69				
Comparison group; prephase	14	1.64	0.74	5.14	0.0075		
Experimental group; postphase	11	2.09	1.04				
Comparison group; postphase	14	2.36	1.06	1.04	0.9726	1.47	0.2375

(continued overleaf)

TABLE F1 (continued)

TEACHERS' REPORTS ON WRITING ACTIVITIES AND PROCEDURES: GRADE 1 STATISTICS

Subscale and Sample	N	Mean Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Teacher as Arbitrator							
Experimental group; prephase	11	3.82	2.04				
Comparison group; prephase	14	4.29	2.05	1.01	1.000		
Experimental group; postphase	11	4.05	2.34				
Comparison group; postphase	14	4.32	2.05	1.30	0.6475	0.00	0.9967
Teacher as Facilitator							
Experimental group; prephase	11	8.00	1.67				
Comparison group; prephase	14	7.79	1.89	1.27	0.7121		
Experimental group; postphase	11	8.14	1.57				
Comparison group; postphase	14	7.68	1.49	1.11	0.8455	0.49	0.4929
Teacher as Observer							
Experimental group; prephase	11	7.64	2.01				
Comparison group; prephase	14	5.50	1.99	1.02	0.9487		
Experimental group; postphase	11	7.91	0.92				
Comparison group; postphase	14	7.29	2.04	4.93	0.0161	0.32	0.5782
Teacher as Model							
Experimental group; prephase	11	5.73	2.80				
Comparison group; prephase	14	5.57	2.24	1.55	0.4505		
Experimental group; postphase	11	5.23	1.47				
Comparison group; postphase	14	5.64	2.44	2.74	0.1172	0.31	0.5843

Teacher as Demonstrator							
Experimental group; prephase	11	4.64	1.63				
Comparison group; prephase	14	4.79	2.15	1.75	0.3805		
Experimental group; postphase	11	4.23	1.29				
Comparison group; postphase	14	4.75	2.20	2.90	0.0987	0.45	0.5095
Teacher as Challenger							
Experimental group; prephase	11	7.09	2.47				
Comparison group; prephase	14	6.93	2.50	1.02	0.9923		
Experimental group; postphase	11	7.32	1.12				
Comparison group; postphase	14	7.61	1.50	1.77	0.3700	0.52	0.4805
Teacher as Expert							
Experimental group; prephase	11	3.64	3.04				
Comparison group; prephase	14	4.50	2.65	1.31	0.6324		
Experimental group; postphase	11	2.82	2.25				
Comparison group; postphase	14	2.96	2.00	1.26	0.6832	0.03	0.8736
Teaching Writing is a Learning Experience							
Experimental group; prephase	11	8.82	1.83				
Comparison group; prephase	14	8.43	1.99	1.18	0.8107		
Experimental group; postphase	11	8.86	0.87				
Comparison group; postphase	14	8.32	1.78	4.21	0.0286	0.57	0.4591

* Postphase differences were tested controlling for prephase differences.

TABLE F2

TEACHERS' REPORTS ON WRITING ACTIVITIES AND PROCEDURES: GRADE 3 STATISTICS

Subscale and Sample	N	Mean Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Teacher Control of Writing Activities							
Experimental group; prephase	13	5.56	1.27				
Comparison group; prephase	14	5.71	1.77	1.94	0.2609		
Experimental group; postphase	13	5.23	1.11				
Comparison group; postphase	14	6.10	1.51	1.85	0.2939	10.76	0.0032
Pupil Control of Writing Activities							
Experimental group; prephase	13	5.98	0.76				
Comparison group; prephase	14	6.04	1.36	3.16	0.0549		
Experimental group; postphase	13	6.38	0.67				
Comparison group; postphase	14	5.80	0.98	2.13	0.2006	5.10	0.0333
Teacher-Pupil Collaboration							
Experimental group; prephase	13	7.50	1.62				
Comparison group; prephase	14	7.50	1.45	1.24	0.7028		
Experimental group; postphase	13	6.94	1.14				
Comparison group; postphase	14	7.48	1.19	1.10	0.8812	1.64	0.2129
Pupil Involvement in Evaluation							
Experimental group; prephase	13	6.73	1.86				
Comparison group; prephase	14	7.18	1.83	1.03	0.9485		
Experimental group; postphase	13	6.92	1.30				
Comparison group; postphase	14	6.55	1.58	1.47	0.5138	1.60	0.2186

Whole-class Instruction							
Experimental group; prephase	13	3.74	1.06				
Comparison group; prephase	14	4.55	1.94	3.31	0.0459		
Experimental group; postphase	13	3.82	1.32				
Comparison group; postphase	14	4.11	1.81	1.89	0.2807	0.29	0.5927
Small Group Instruction							
Experimental group; prephase	13	3.77	2.17				
Comparison group; prephase	14	3.04	1.61	1.81	0.3030		
Experimental group; postphase	13	3.35	1.59				
Comparison group; postphase	14	3.84	2.44	2.35	0.1483	1.91	0.1799
Individual Instruction							
Experimental group; prephase	13	7.08	1.86				
Comparison group; prephase	14	7.04	1.45	1.65	0.3838		
Experimental group; postphase	13	7.21	1.48				
Comparison group; postphase	14	6.89	1.35	1.21	0.7351	0.42	0.5250
Teacher as Lecturer							
Experimental group; prephase	13	2.62	1.50				
Comparison group; prephase	14	2.86	1.88	1.56	0.4501		
Experimental group; postphase	13	2.69	1.70				
Comparison group; postphase	14	2.96	1.57	1.17	0.7814	0.06	0.8036

(continued overleaf)

TABLE F2 (continued)

TEACHERS' REPORTS ON WRITING ACTIVITIES AND PROCEDURES: GRADE 3 STATISTICS

Subscale and Sample	N	Mean Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Teacher as Arbitrator							
Experimental group; prephase	13	3.77	2.01				
Comparison group; prephase	14	3.86	2.77	1.91	0.2736		
Experimental group; postphase	13	3.65	1.84				
Comparison group; postphase	14	4.39	1.65	1.24	0.7051	1.46	0.2391
Teacher as Facilitator							
Experimental group; prephase	13	8.08	1.71				
Comparison group; prephase	14	7.86	1.23	1.92	0.2579		
Experimental group; postphase	13	7.46	1.78				
Comparison group; postphase	14	8.18	1.19	2.26	0.1585	4.66	0.0410
Teacher as Observer							
Experimental group; prephase	13	6.23	2.59				
Comparison group; prephase	14	6.21	2.55	1.03	0.9513		
Experimental group; postphase	13	6.42	1.41				
Comparison group; postphase	14	7.21	1.49	1.11	0.8585	2.71	0.1128
Teacher as Model							
Experimental group; prephase	13	5.62	2.40				
Comparison group; prephase	14	4.21	1.63	2.18	0.1783		
Experimental group; postphase	13	5.00	2.06				
Comparison group; postphase	14	4.25	1.77	1.35	0.5965	0.10	0.7492

Teacher as Demonstrator							
Experimental group; prephase	13	4.69	1.89				
Comparison group; prephase	14	4.21	1.42	1.76	0.3263		
Experimental group; postphase	13	4.42	1.91				
Comparison group; postphase	14	4.54	1.82	1.10	0.8621	0.24	0.6297
Teacher as Challenger							
Experimental group; prephase	13	6.92	1.55				
Comparison group; prephase	14	6.86	2.07	1.78	0.3278		
Experimental group; postphase	13	7.31	1.39				
Comparison group; postphase	14	7.39	1.80	1.67	0.3830	0.10	0.7567
Teacher as Expert							
Experimental group; prephase	13	4.23	2.95				
Comparison group; prephase	14	4.79	3.33	1.28	0.6780		
Experimental group; postphase	13	4.27	2.97				
Comparison group; postphase	14	4.68	3.42	1.32	0.6333	0.00	0.9834
Teaching Writing is a Learning Experience							
Experimental group; prephase	13	7.85	2.61				
Comparison group; prephase	14	7.93	1.77	2.16	0.1823		
Experimental group; postphase	13	7.77	2.32				
Comparison group; postphase	14	7.75	1.42	2.66	0.0926	0.01	0.9214

* Postphase differences were tested controlling for prephase differences.

TABLE F3

TEACHERS' REPORTS ON WRITING ACTIVITIES AND PROCEDURES: GRADE 6 STATISTICS

Subscale and Sample	N	Mean Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Teacher Control of Writing Activities							
Experimental group; prephase	15	5.36	0.68				
Comparison group; prephase	13	6.13	1.10	2.63	0.0873		
Experimental group; postphase	15	5.26	0.88				
Comparison group; postphase	13	5.79	0.91	1.07	0.8947	0.01	0.9086
Pupil Control of Writing Activities							
Experimental group; prephase	15	5.96	1.32				
Comparison group; prephase	13	6.05	1.47	1.24	0.6905		
Experimental group; postphase	15	6.44	0.95				
Comparison group; postphase	13	6.09	1.10	1.33	0.6088	2.10	0.1596
Teacher-Pupil Collaboration							
Experimental group; prephase	15	7.03	1.29				
Comparison group; prephase	13	7.69	1.47	1.29	0.6385		
Experimental group; postphase	15	6.80	1.00				
Comparison group; postphase	13	7.63	1.04	1.08	0.8839	2.85	0.1039
Pupil Involvement in Evaluation							
Experimental group; prephase	15	6.63	1.58				
Comparison group; prephase	13	6.62	2.02	1.65	0.3698		
Experimental group; postphase	15	6.77	1.80				
Comparison group; postphase	13	6.71	1.89	1.10	0.8543	0.01	0.9288

Whole-class Instruction							
Experimental group; prephase	15	3.89	1.15				
Comparison group; prephase	13	3.77	2.17	3.58	0.0260		
Experimental group; postphase	15	3.93	1.05				
Comparison group; postphase	13	3.72	1.67	2.53	0.1001	0.14	0.7105
Small Group Instruction							
Experimental group; prephase	15	4.23	1.52				
Comparison group; prephase	13	3.62	2.33	2.34	0.1315		
Experimental group; postphase	15	4.12	1.81				
Comparison group; postphase	13	3.40	2.05	1.28	0.6523	0.34	0.5659
Individual Instruction							
Experimental group; prephase	15	7.17	1.30				
Comparison group; prephase	13	6.77	1.67	1.63	0.3802		
Experimental group; postphase	15	6.57	1.10				
Comparison group; postphase	13	7.13	1.33	1.46	0.4924	4.40	0.0463
Teacher as Lecturer							
Experimental group; prephase	15	3.07	1.53				
Comparison group; prephase	13	3.08	1.61	1.10	0.8608		
Experimental group; postphase	15	3.10	1.07				
Comparison group; postphase	13	3.31	1.44	1.79	0.2955	0.39	0.5380

(continued overleaf)

TABLE F3 (continued)

TEACHERS' REPORTS ON WRITING ACTIVITIES AND PROCEDURES: GRADE 6 STATISTICS

Subscale and Sample	N	Mean Score	Standard Deviation	t-Test F	t-Test Prob GT F	Covariate Test* F	Covariate Test* Prob GT F
Teacher as Arbitrator							
Experimental group; prephase	15	4.87	2.13				
Comparison group; prephase	13	5.00	2.89	1.83	0.2798		
Experimental group; postphase	15	4.67	2.07				
Comparison group; postphase	13	4.54	2.64	1.63	0.3789	0.04	0.8464
Teacher as Facilitator							
Experimental group; prephase	15	7.13	1.41				
Comparison group; prephase	13	7.46	2.73	3.75	0.0211		
Experimental group; postphase	15	6.50	1.64				
Comparison group; postphase	13	7.58	1.79	1.20	0.7417	3.09	0.0912
Teacher as Observer							
Experimental group; prephase	15	6.80	1.37				
Comparison group; prephase	13	6.77	2.00	2.13	0.1774		
Experimental group; postphase	15	6.13	1.37				
Comparison group; postphase	13	6.92	1.93	2.00	0.2174	1.55	0.2247
Teacher as Model							
Experimental group; prephase	15	5.00	2.00				
Comparison group; prephase	13	4.54	2.54	1.61	0.3930		
Experimental group; postphase	15	4.27	2.04				
Comparison group; postphase	13	3.58	1.93	1.11	0.8594	0.61	0.4430

Teacher as Demonstrator							
Experimental group; prephase	15	5.13	1.55				
Comparison group; prephase	13	3.77	1.88	1.46	0.4922		
Experimental group; postphase	15	4.27	1.60				
Comparison group; postphase	13	3.46	1.61	1.01	0.9690	0.69	0.4133
Teacher as Challenger							
Experimental group; prephase	15	6.80	1.66				
Comparison group; prephase	13	7.46	1.85	1.25	0.6801		
Experimental group; postphase	15	6.10	1.45				
Comparison group; postphase	13	7.81	1.95	1.80	0.2914	6.18	0.0199
Teacher as Expert							
Experimental group; prephase	15	3.40	1.68				
Comparison group; prephase	13	4.46	2.96	3.10	0.0469		
Experimental group; postphase	15	3.33	1.90				
Comparison group; postphase	13	5.12	1.83	1.08	0.9081	4.53	0.0433
Teaching Writing is a Learning Experience							
Experimental group; prephase	15	7.53	2.13				
Comparison group; prephase	13	8.31	1.75	1.49	0.4978		
Experimental group; postphase	15	7.30	1.19				
Comparison group; postphase	13	8.42	1.68	1.99	0.2204	3.00	0.0956

* Postphase differences were tested controlling for prephase differences.

FIGURES 1-32

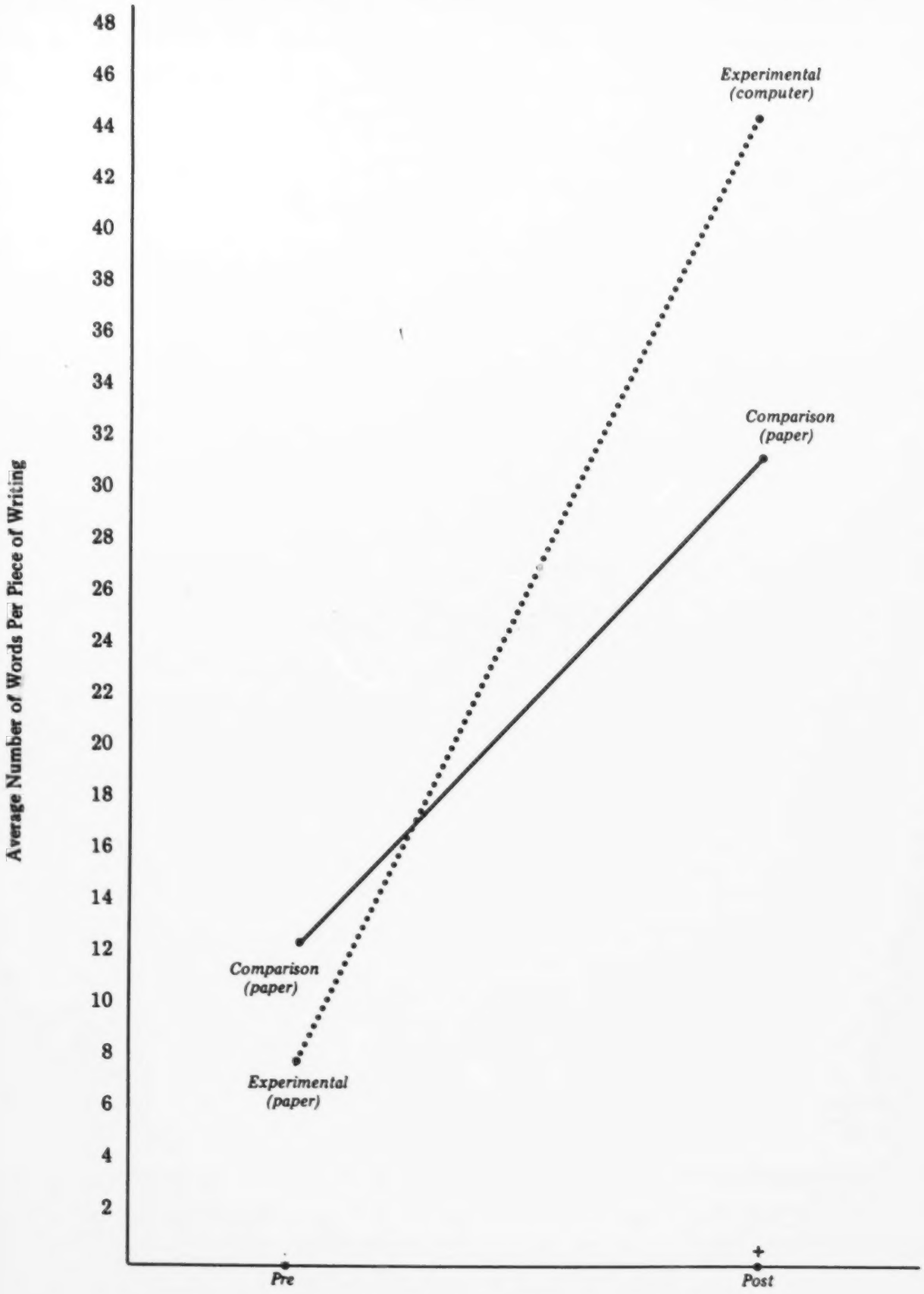

Figure 1. *Quantity of Writing: Grade 1 Experimental and Comparison Groups — Computer vs. Paper*

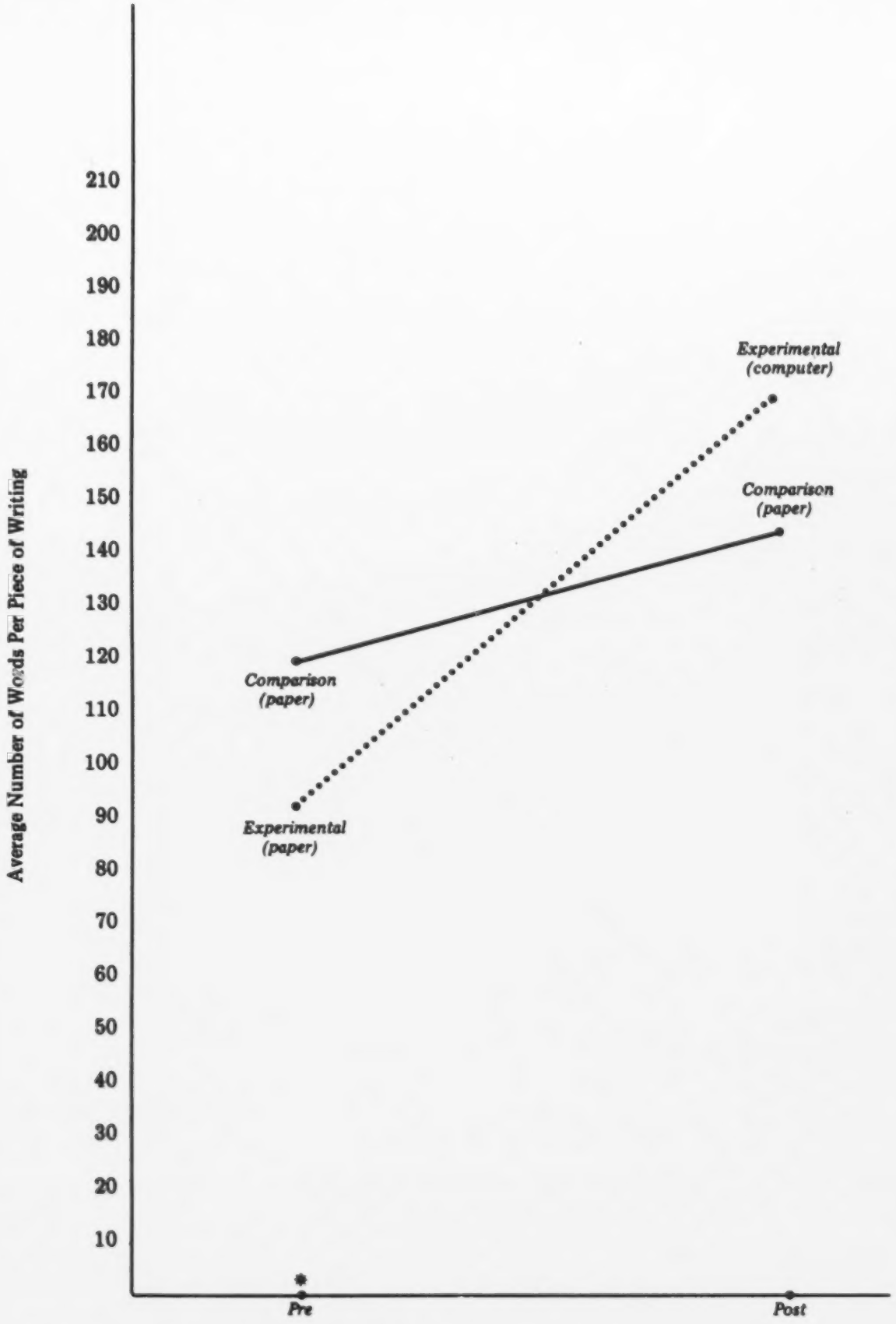

Figure 2. *Quantity of Writing: Grade 3 Experimental and Comparison Groups — Computer vs. Paper*

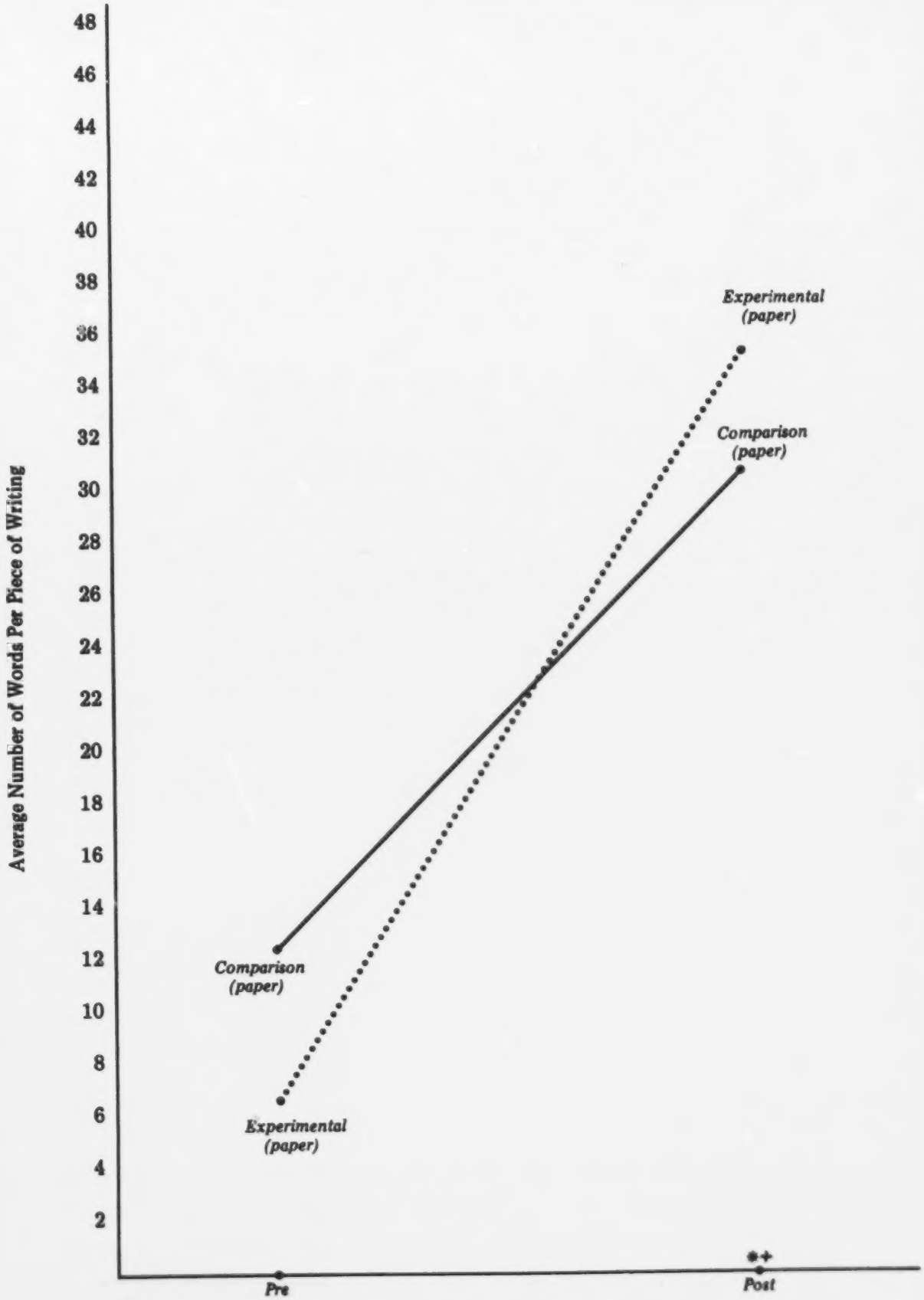

Figure 3. *Quantity of Writing: Grade 1 Experimental and Comparison Groups — Paper vs. Paper*

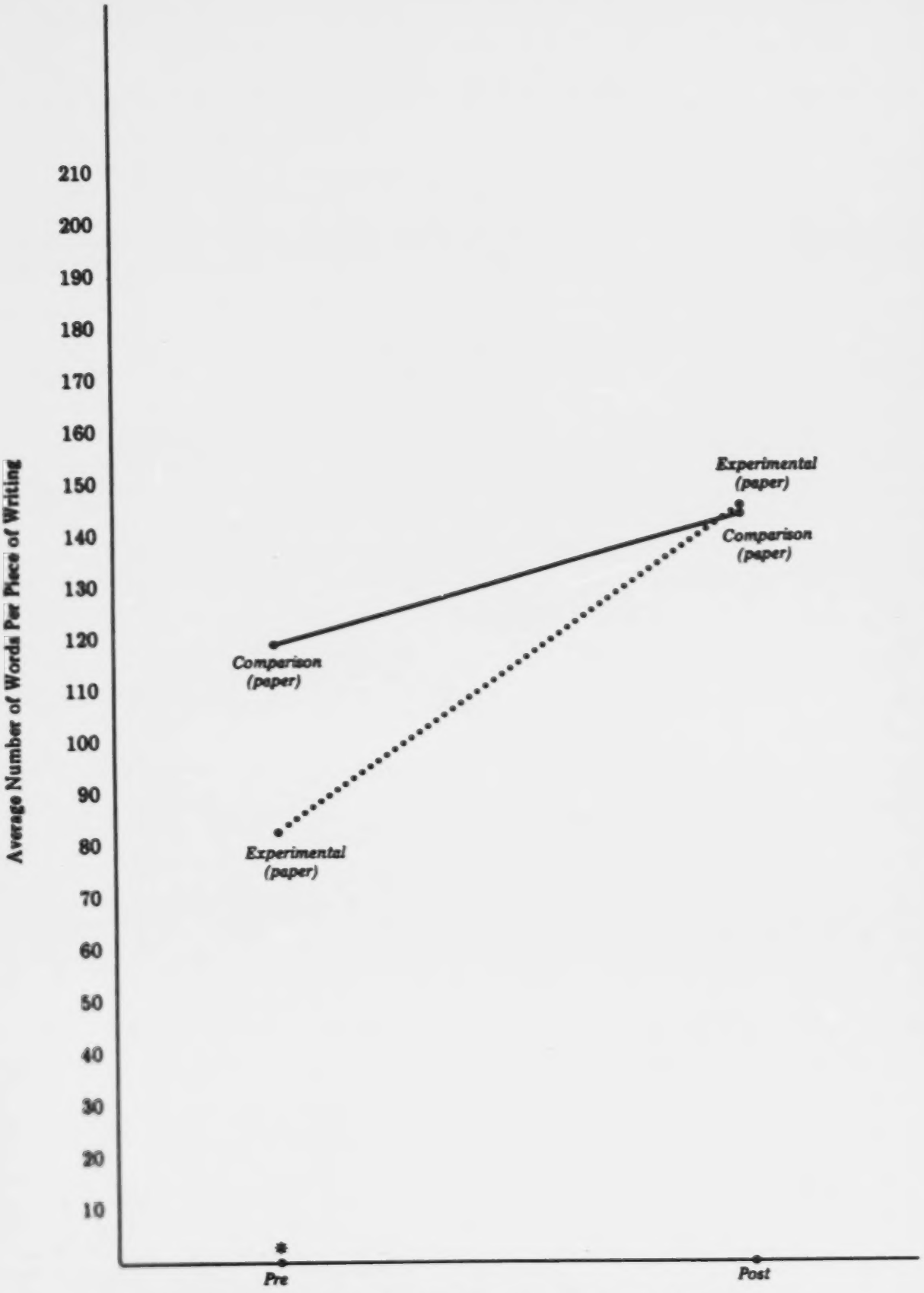

Figure 4. *Quantity of Writing: Grade 3 Experimental and Comparison Groups — Paper vs. Paper*

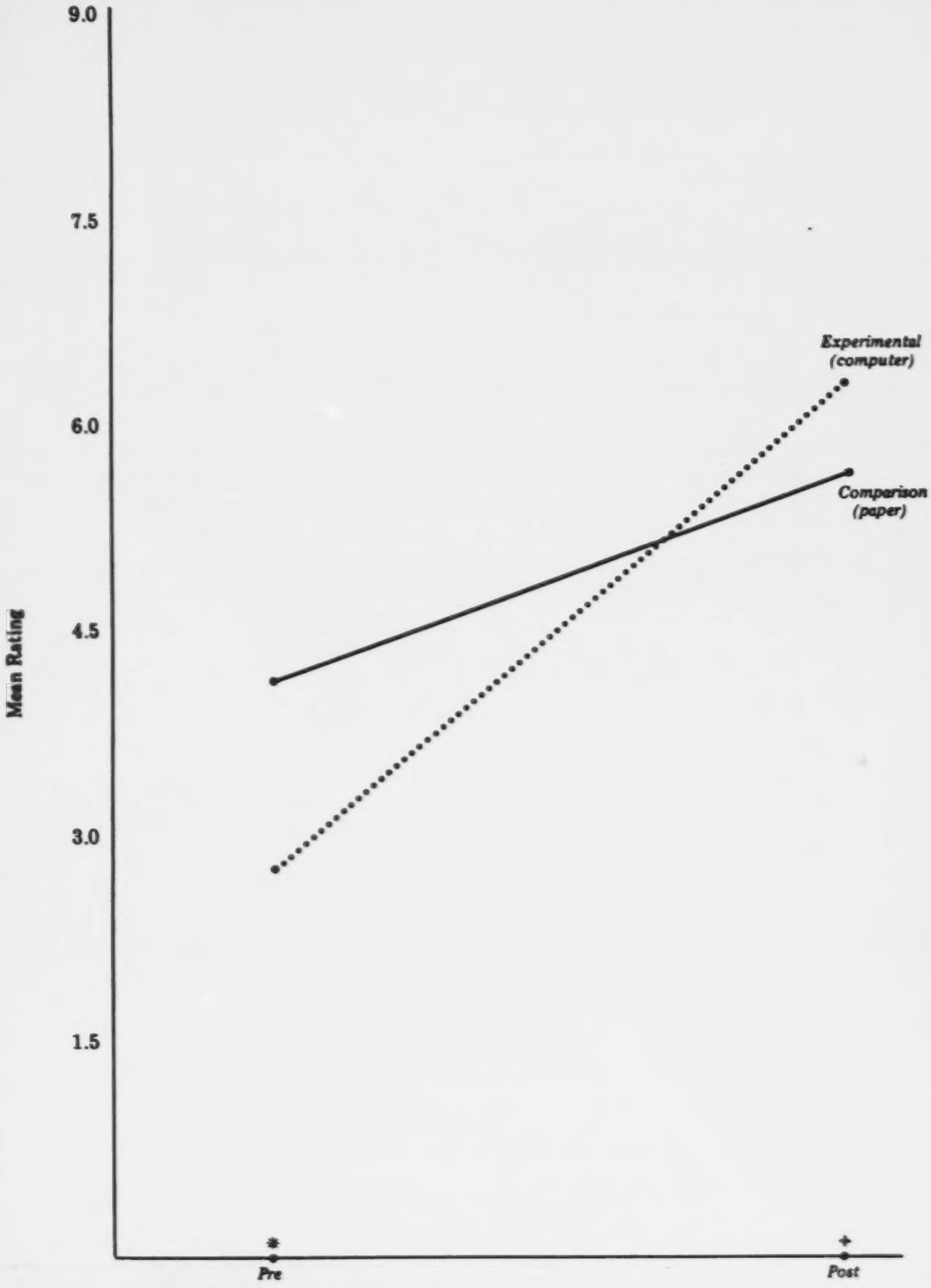

Figure 5. *Quality of Writing: Grade 1 Experimental and Comparison Groups — Holistic Marking — Computer vs. Paper*

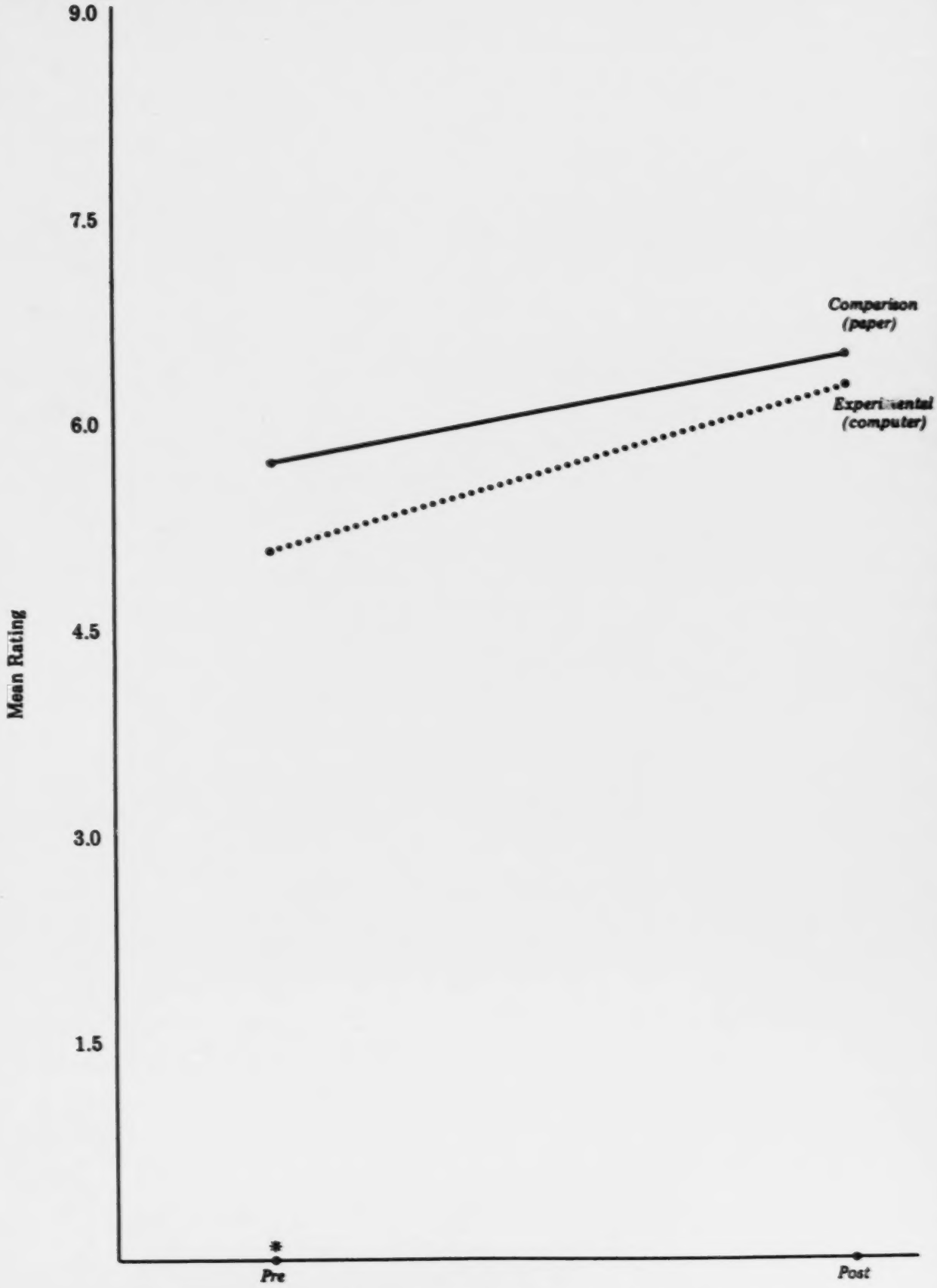

Figure 6. *Quality of Writing: Grade 3 Experimental and Comparison Groups — Holistic Marking — Computer vs. Paper*

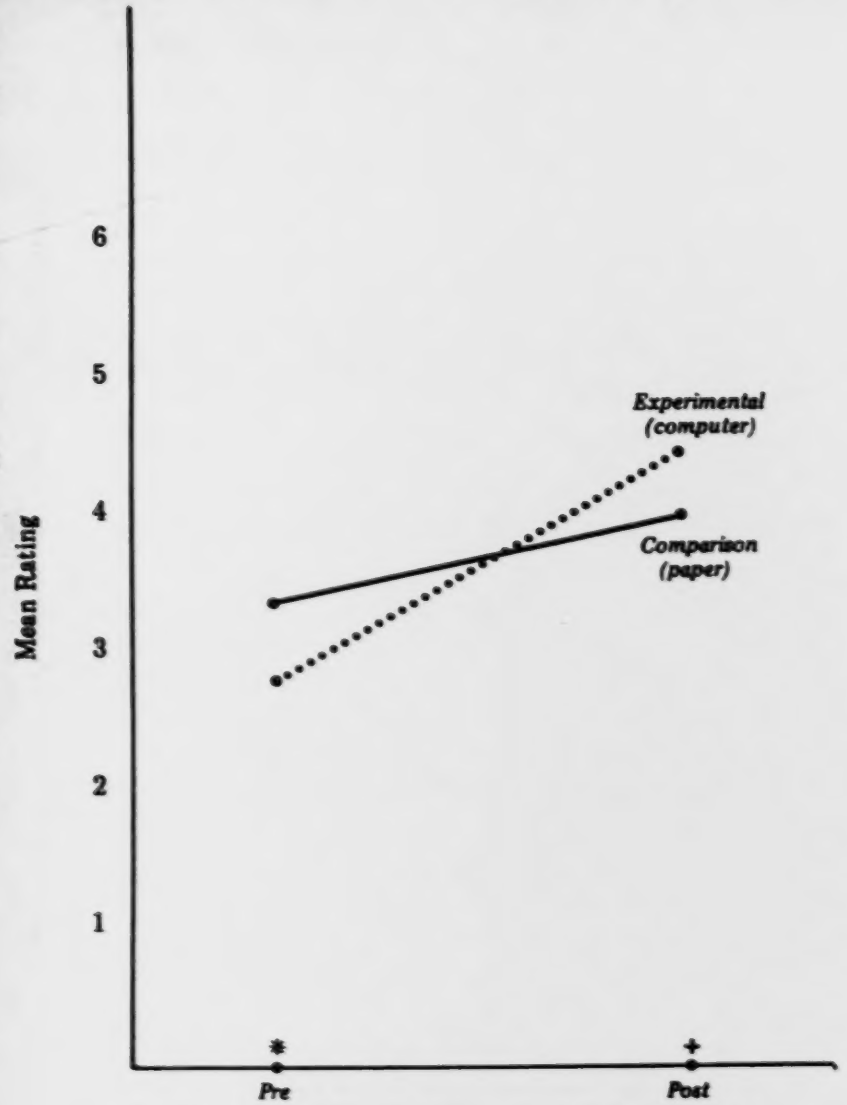

Figure 7. *Quality of Writing: Grade 1 Experimental and Comparison Groups — Analytic Marking/ IDEAS Subscale — Computer vs. Paper*

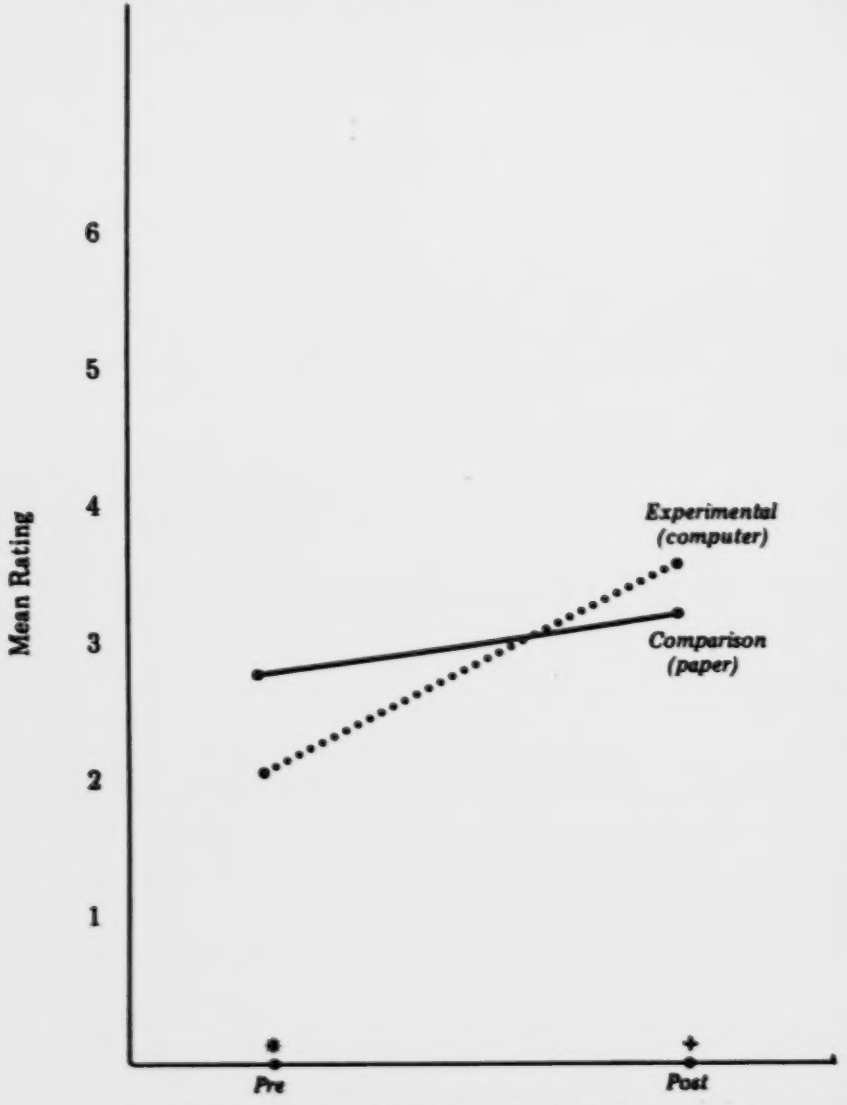

Figure 8. *Quality of Writing: Grade 1 Experimental and Comparison Groups — Analytic Marking/ ORGANIZATION Subscale — Computer vs. Paper*

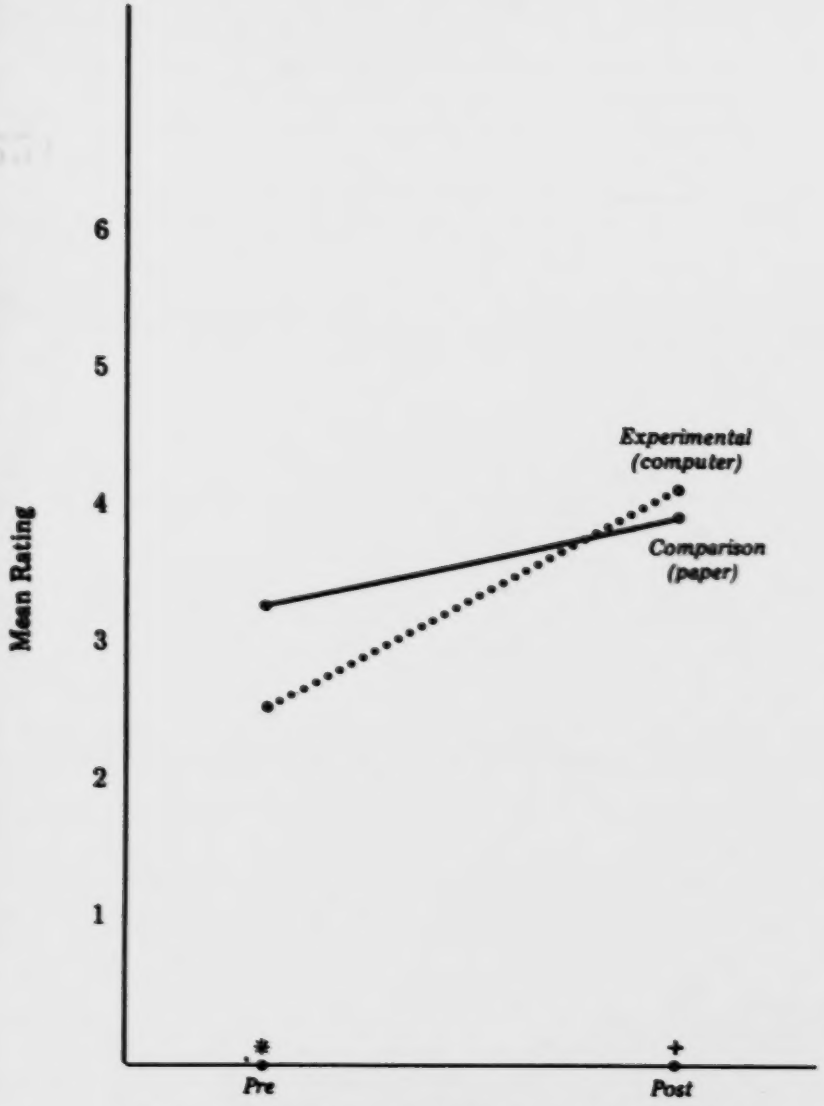

Figure 9. *Quality of Writing: Grade 1 Experimental and Comparison Groups — Analytic Marking/ SYNTAX Subscale — Computer vs. Paper*

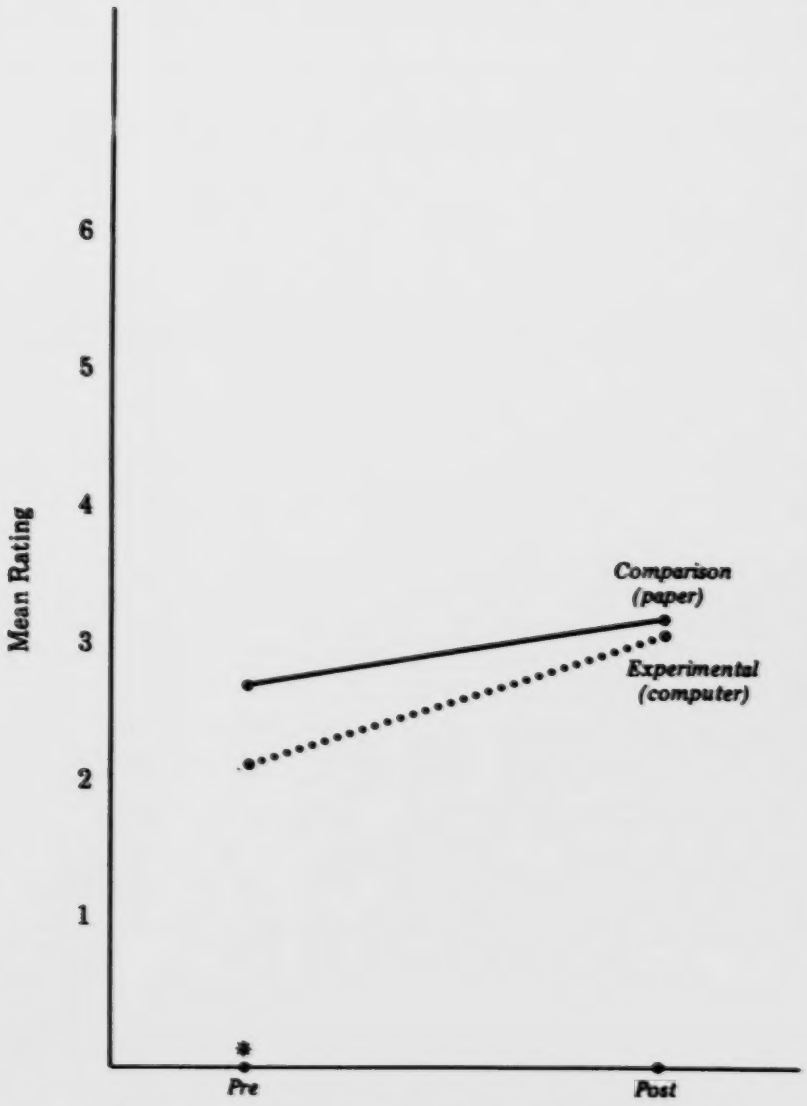

Figure 10. *Quality of Writing: Grade 1 Experimental and Comparison Groups — Analytic Marking/ PUNCTUATION/CAPITALIZATION Subscale — Computer vs. Paper*

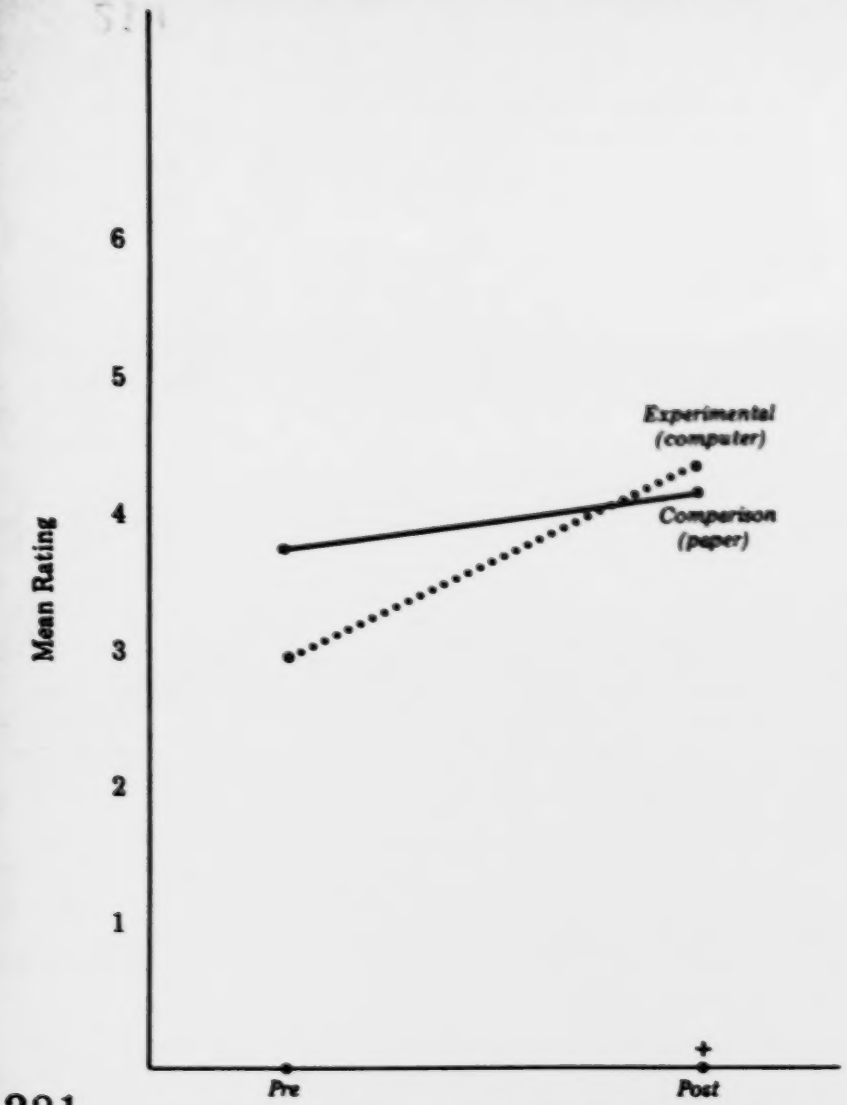

Figure 11. *Quality of Writing: Grade 1 Experimental and Comparison Groups — Analytic Marking/ SPELLING Subscale — Computer vs. Paper*

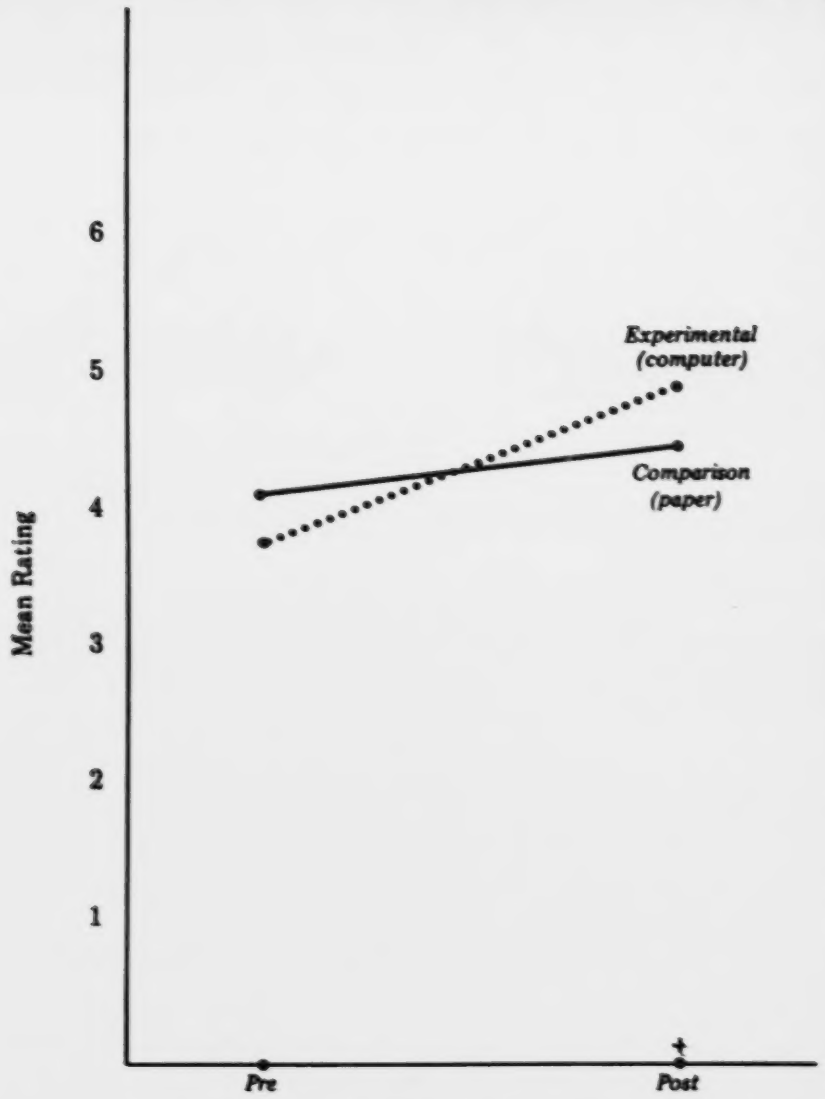

Figure 12. *Quality of Writing: Grade 3 Experimental and Comparison Groups — Analytic Marking/ IDEAS Subscale — Computer vs. Paper*

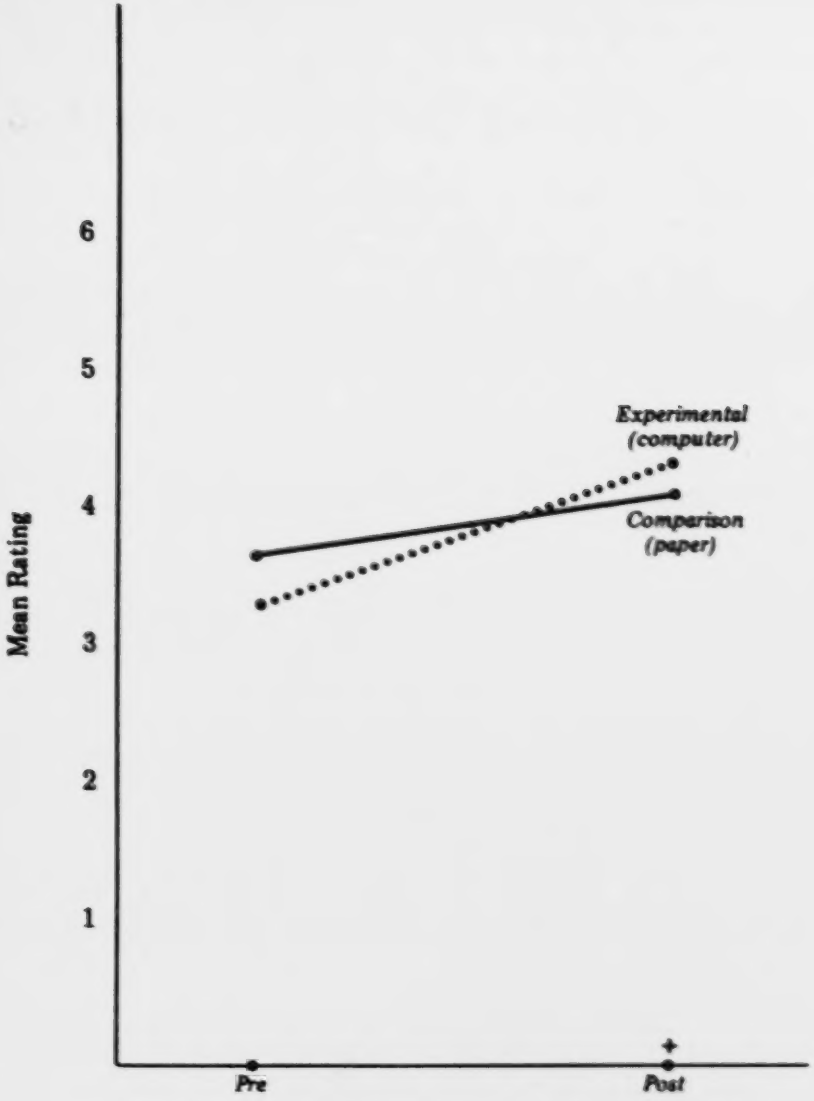

Figure 13. *Quality of Writing: Grade 3 Experimental and Comparison Groups — Analytic Marking/ USAGE/WORD CHOICE Subscale — Computer vs. Paper*

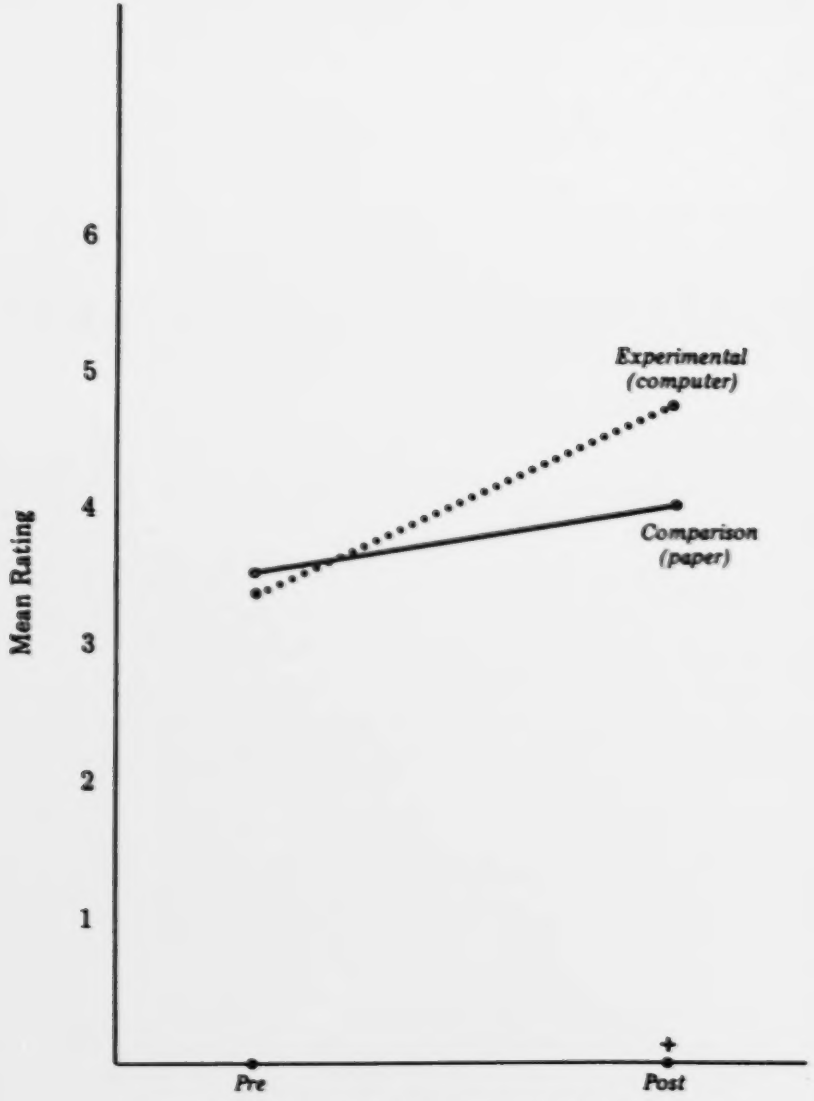

Figure 14. *Quality of Writing: Grade 3 Experimental and Comparison Groups — Analytic Marking/ PUNCTUATION/CAPITALIZATION Subscale — Computer vs. Paper*

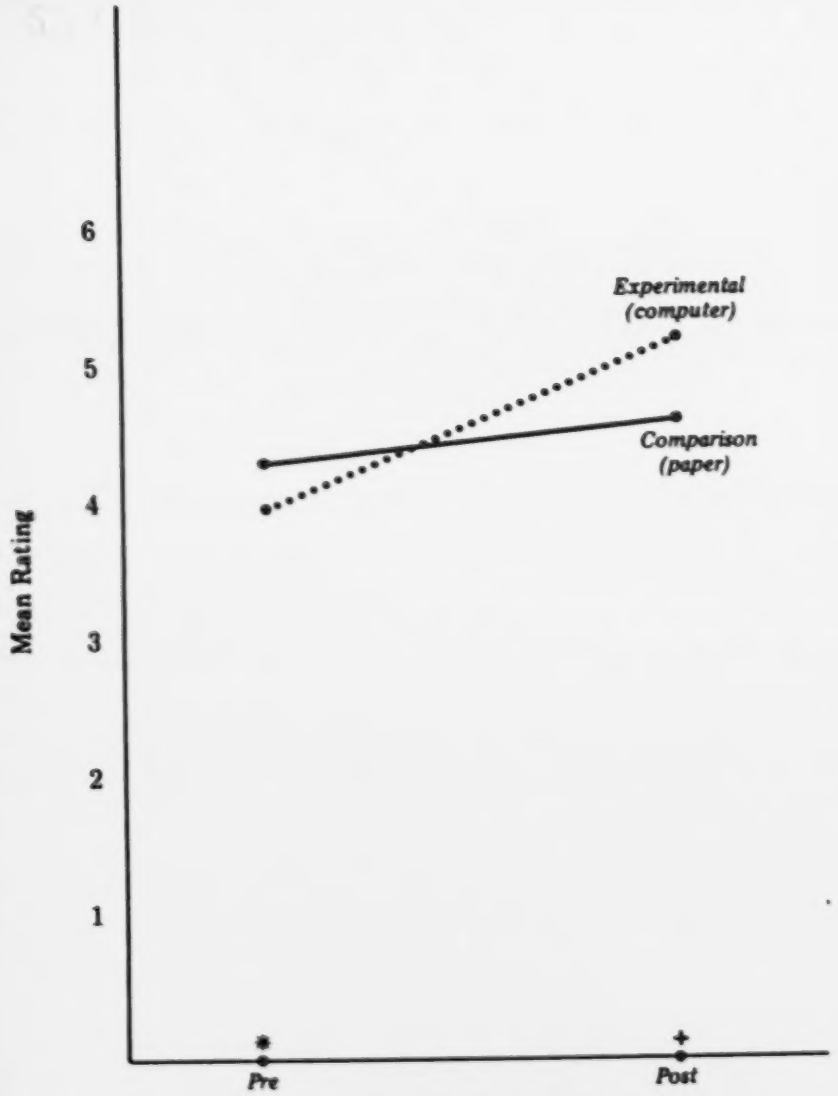

Figure 15. *Quality of Writing: Grade 3 Experimental and Comparison Groups — Analytic Marking/ SPELLING Subscale — Computer vs. Paper*

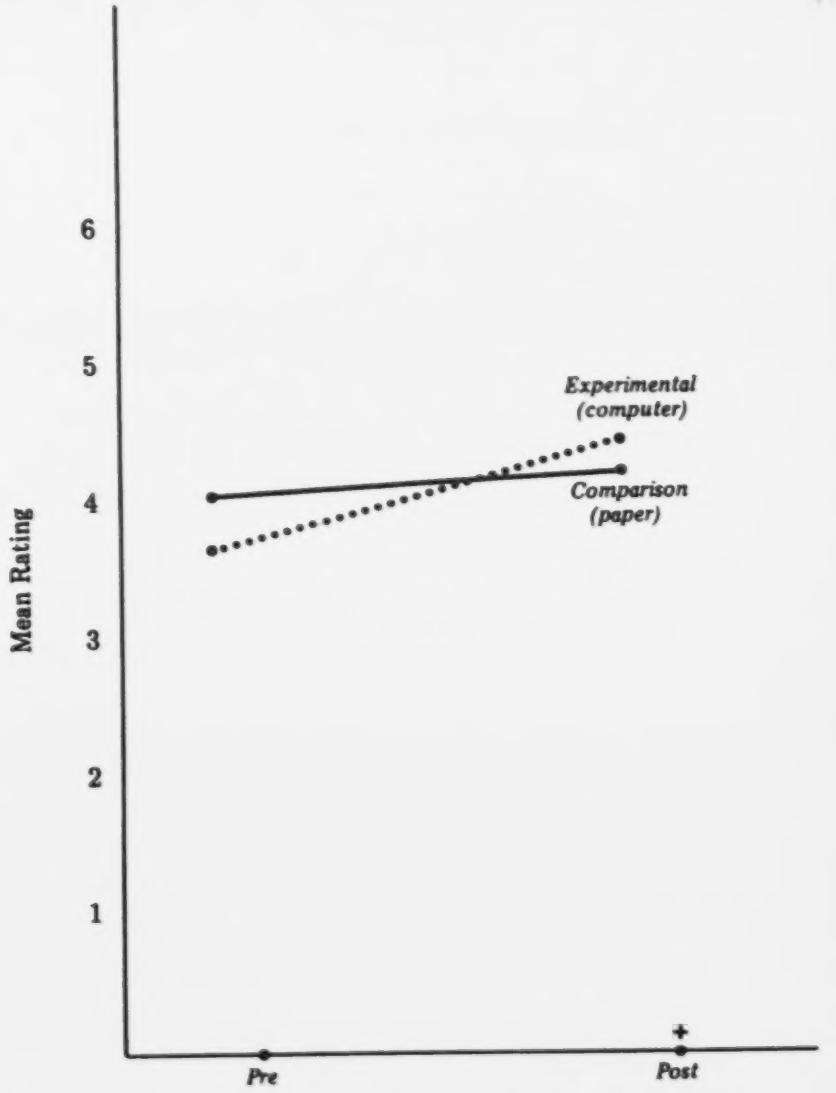

Figure 16. *Quality of Writing: Grade 6 Experimental and Comparison Groups — Analytic Marking/ SYNTAX Subscale — Computer vs. Paper*

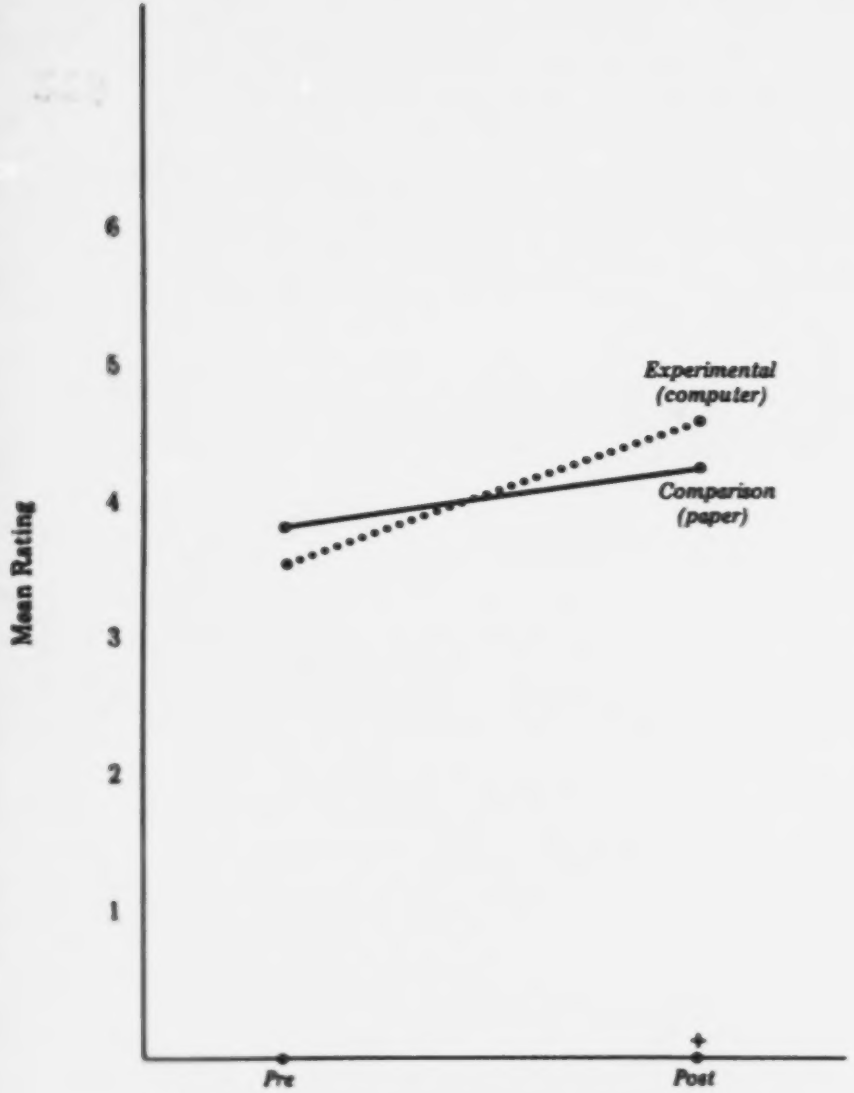

Figure 17. *Quality of Writing: Grade 6 Experimental and Comparison Groups — Analytic Marking/ USAGE/WORD CHOICE Subscale — Computer vs. Paper*

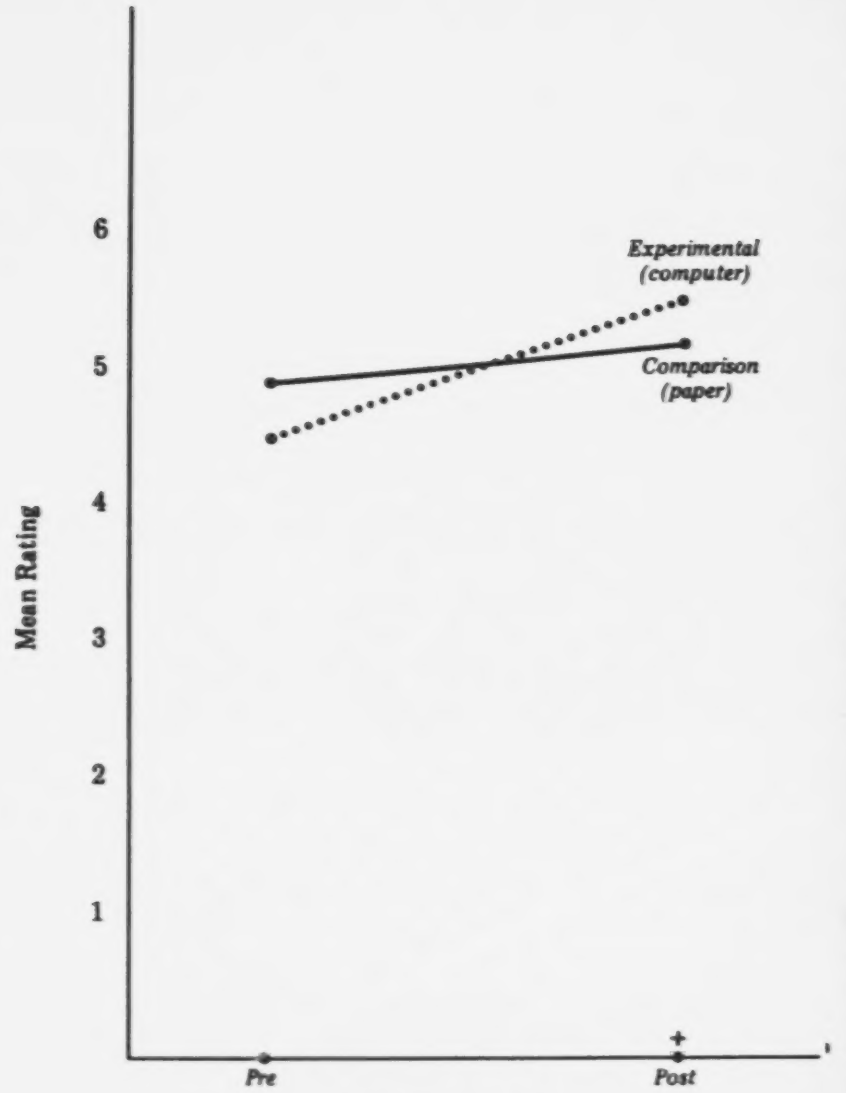

Figure 18. *Quality of Writing: Grade 6 Experimental and Comparison Groups — Analytic Marking/ SPELLING Subscale — Computer vs. Paper*

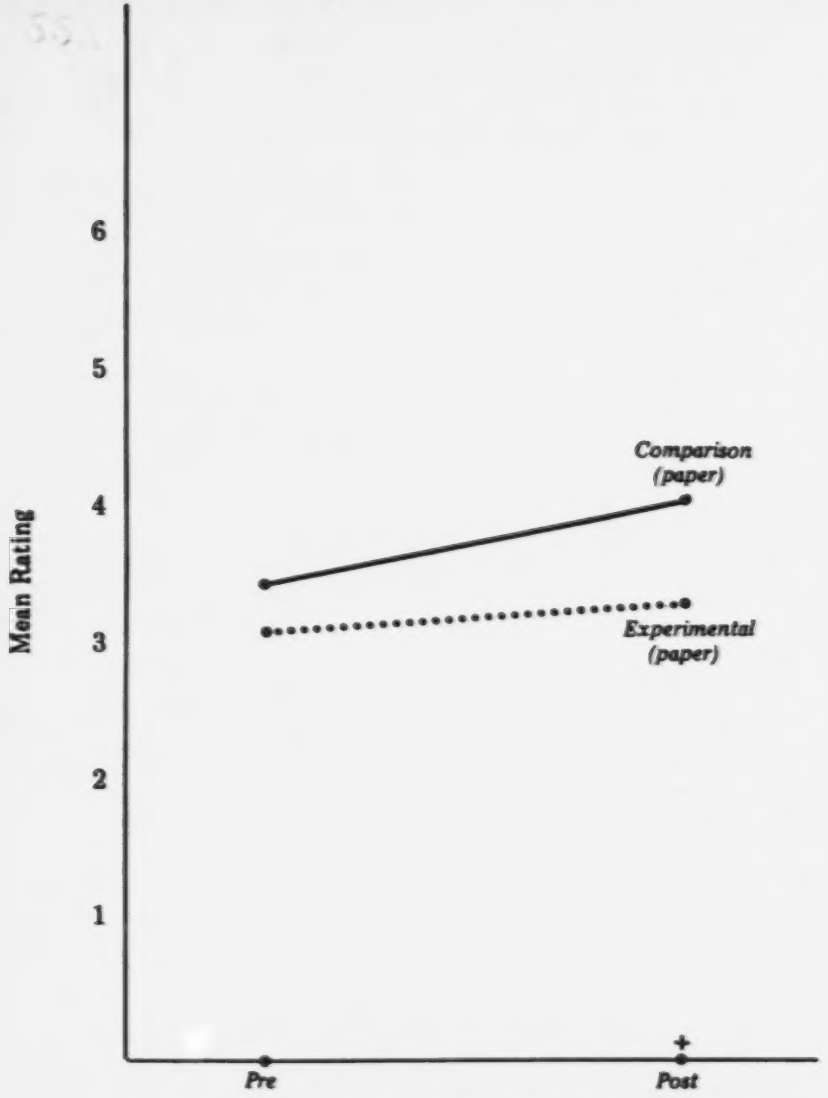

Figure 19. *Quality of Writing: Grade 3 Experimental and Comparison Groups — Analytic Marking/ SYNTAX Subscale — Paper vs. Paper*

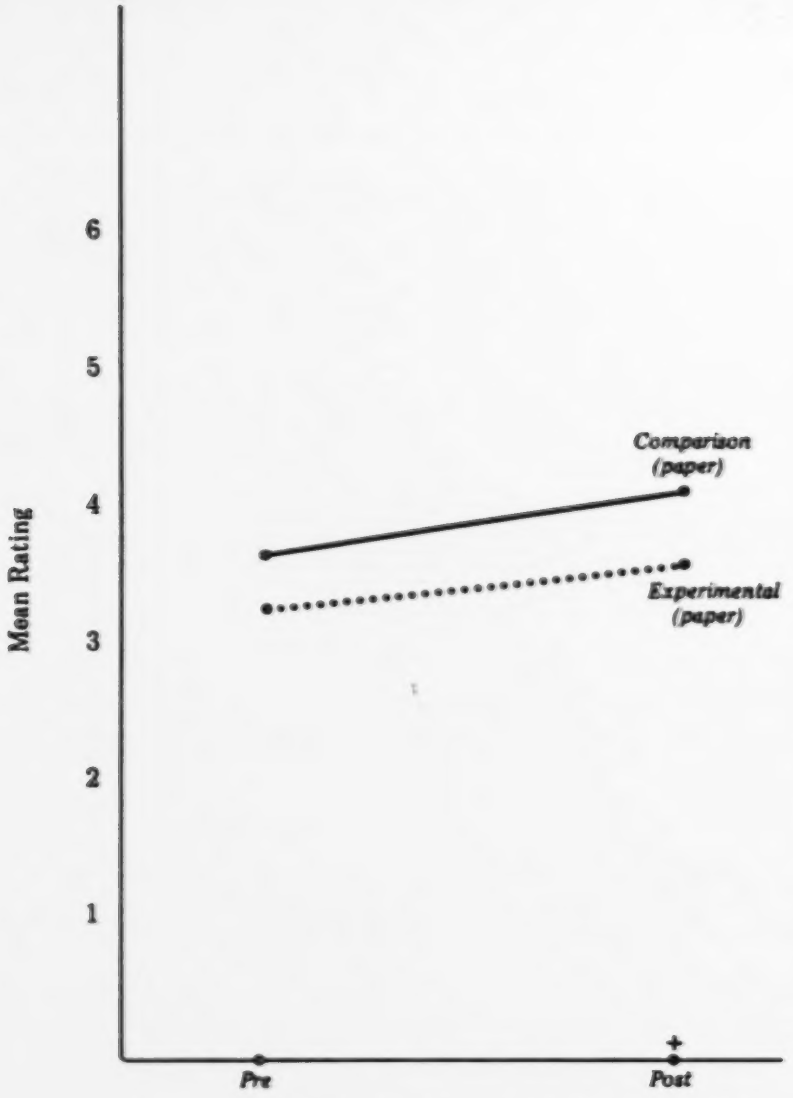

Figure 20. *Quality of Writing: Grade 3 Experimental and Comparison Groups — Analytic Marking/ USAGE/WORD CHOICE Subscale — Paper vs. Paper*

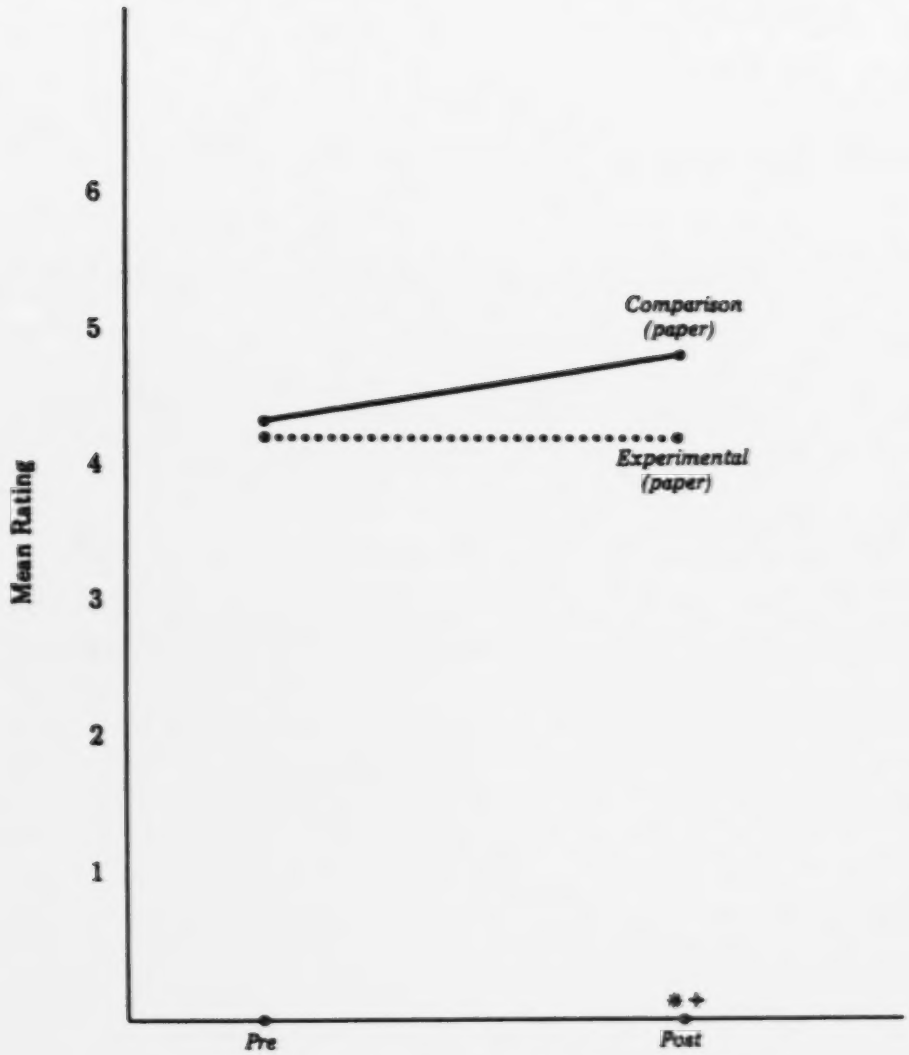

Figure 21. *Quality of Writing: Grade 6 Experimental and Comparison Groups — Analytic Marking/ IDEAS Subscale — Paper vs. Paper*

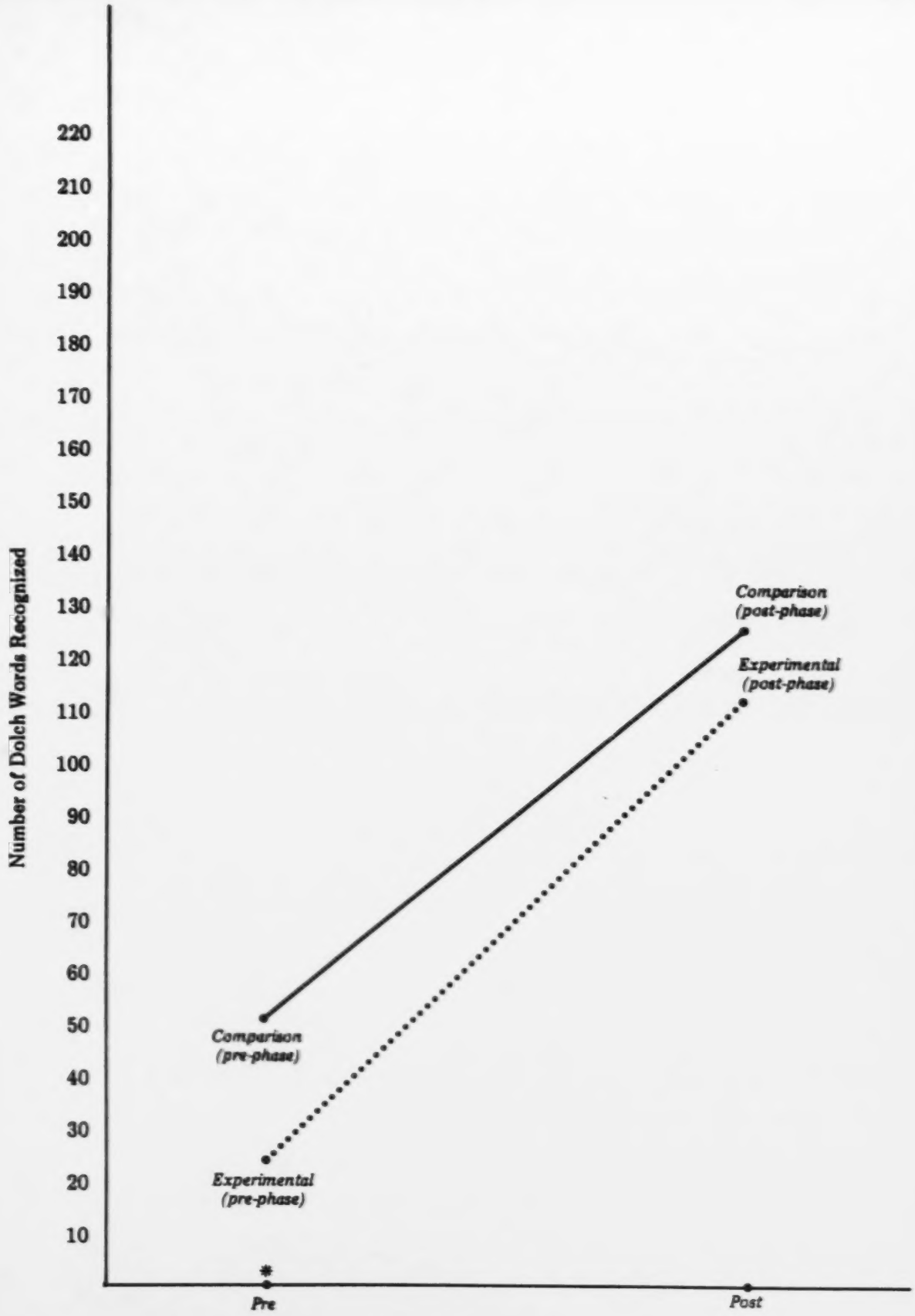

Figure 22. *Dolch Sight Word Recognition: Grade 1 Experimental and Comparison Groups*

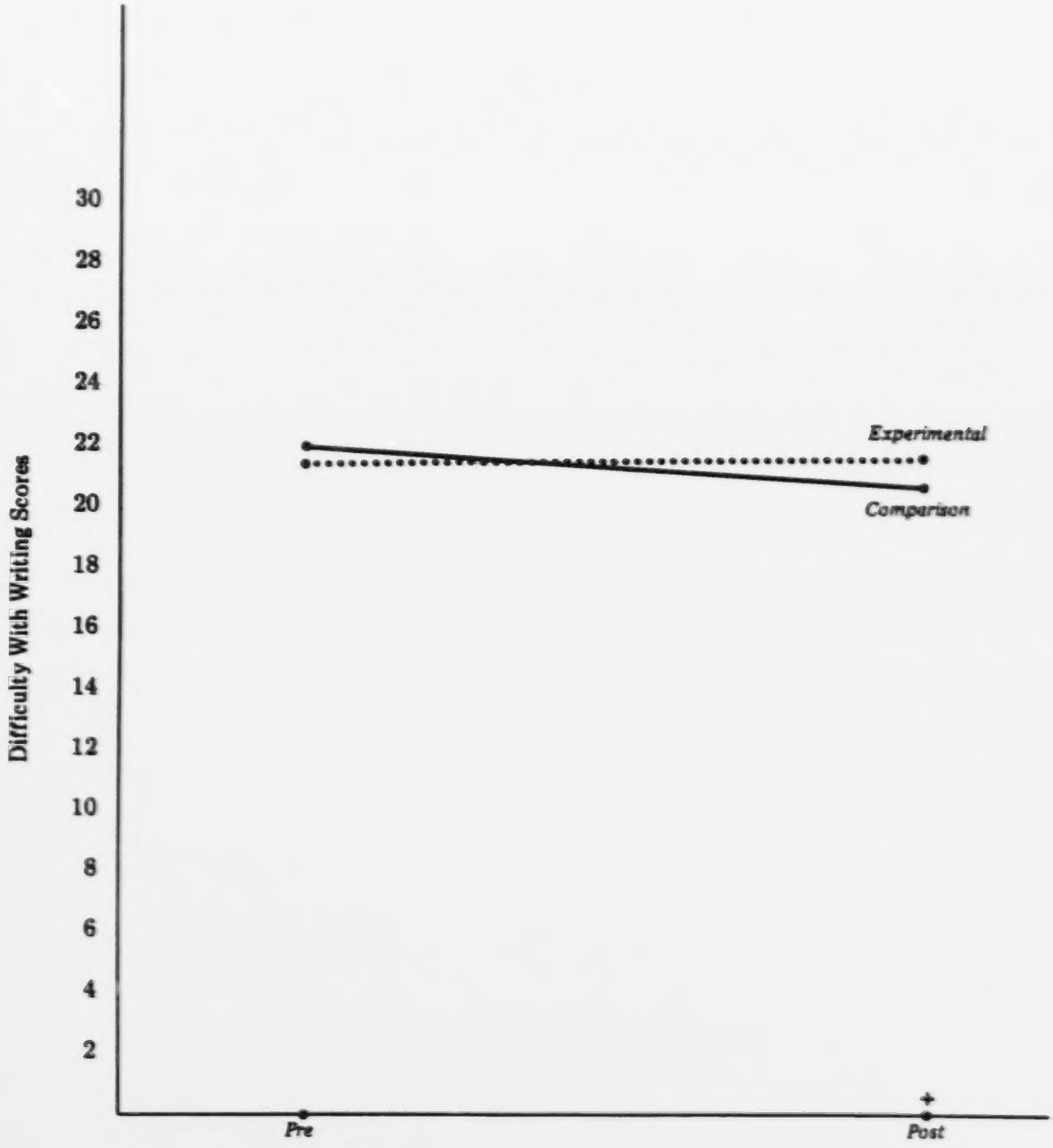

Figure 23. *Attitude Toward Writing for Grade 6 Experimental and Comparison Children: DIFFICULTY WITH WRITING. (Note that a high score indicates an attitude that writing is easy.)*

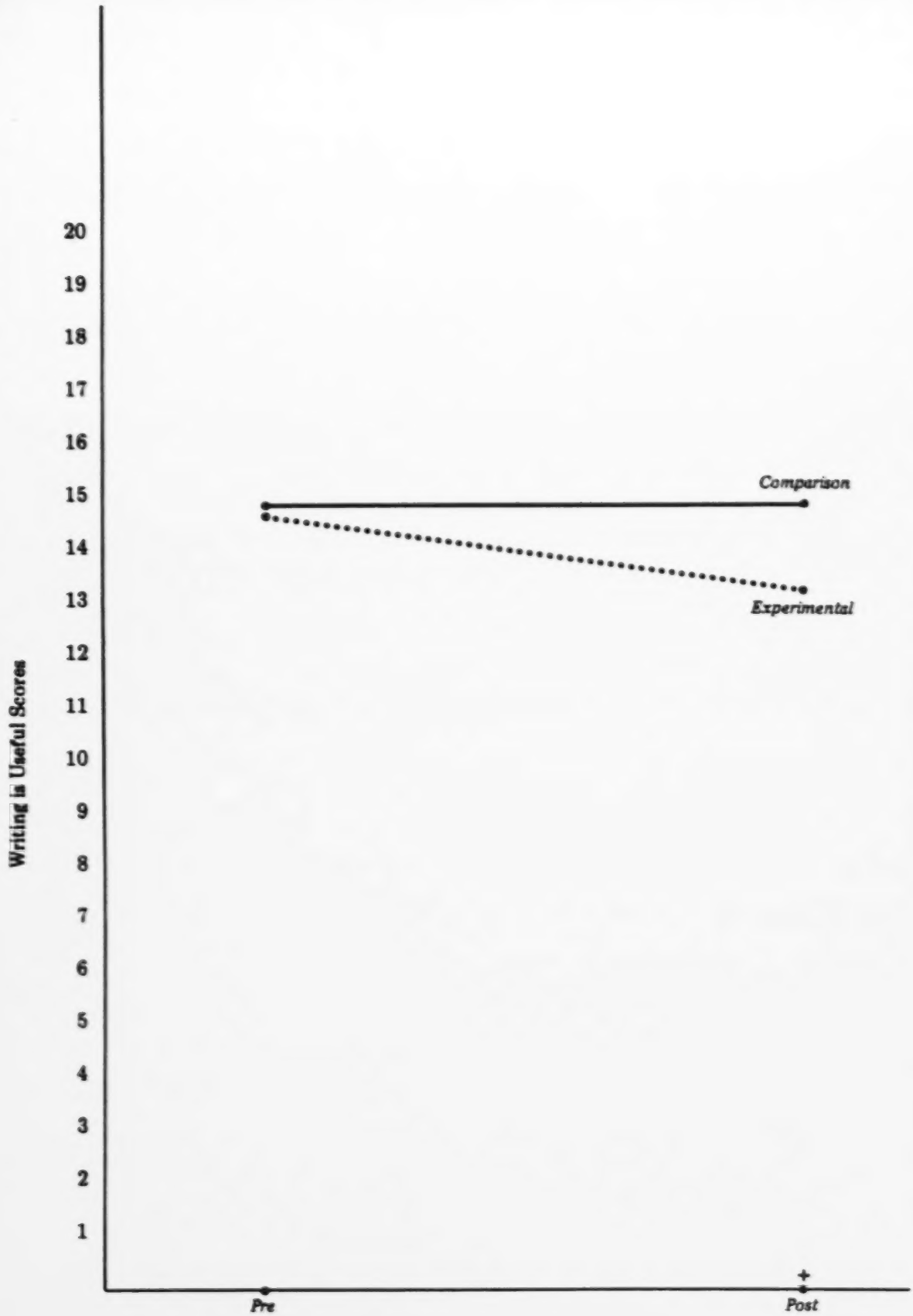

Figure 24. *Attitude Toward Writing for Grade 6 Experimental and Comparison Children: WRITING IS USEFUL.*

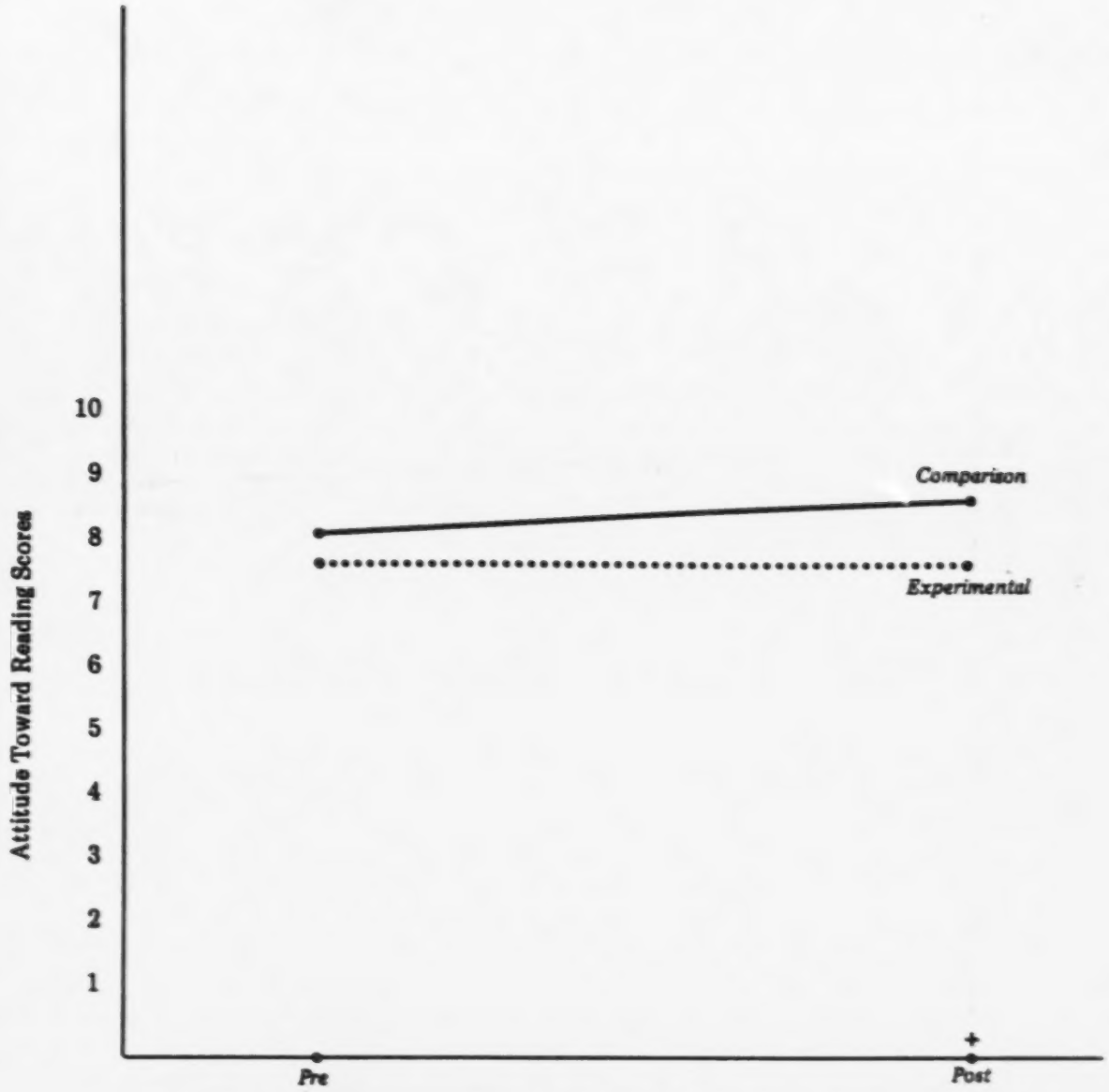

Figure 25. *Attitude Toward Writing for Grade 6 Experimental and Comparison Children: ATTITUDE TOWARD READING*

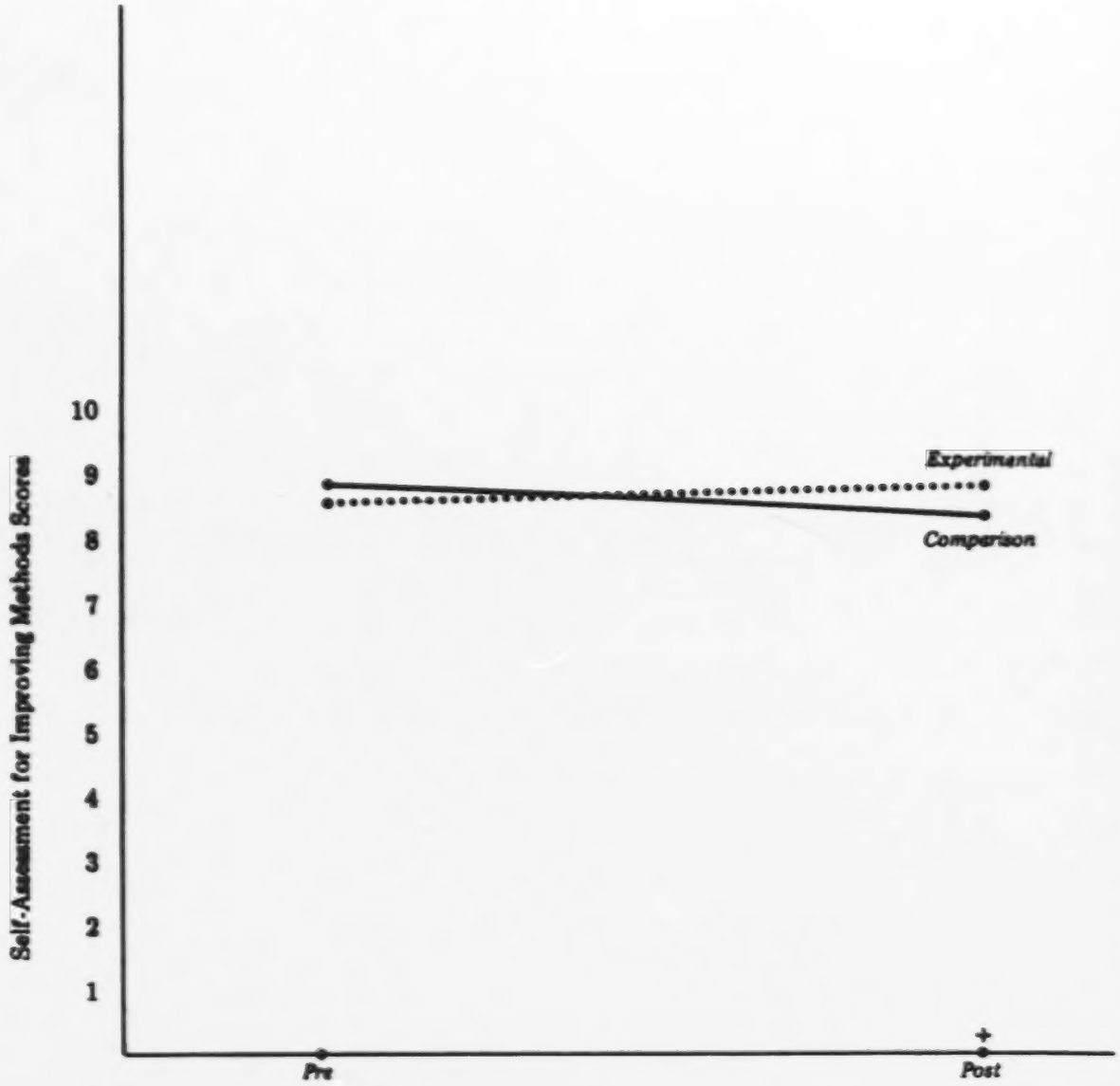

Figure 26. *Attitude Toward Teaching Writing: SELF-ASSESSMENT FOR IMPROVING METHODS. Grade 1.*

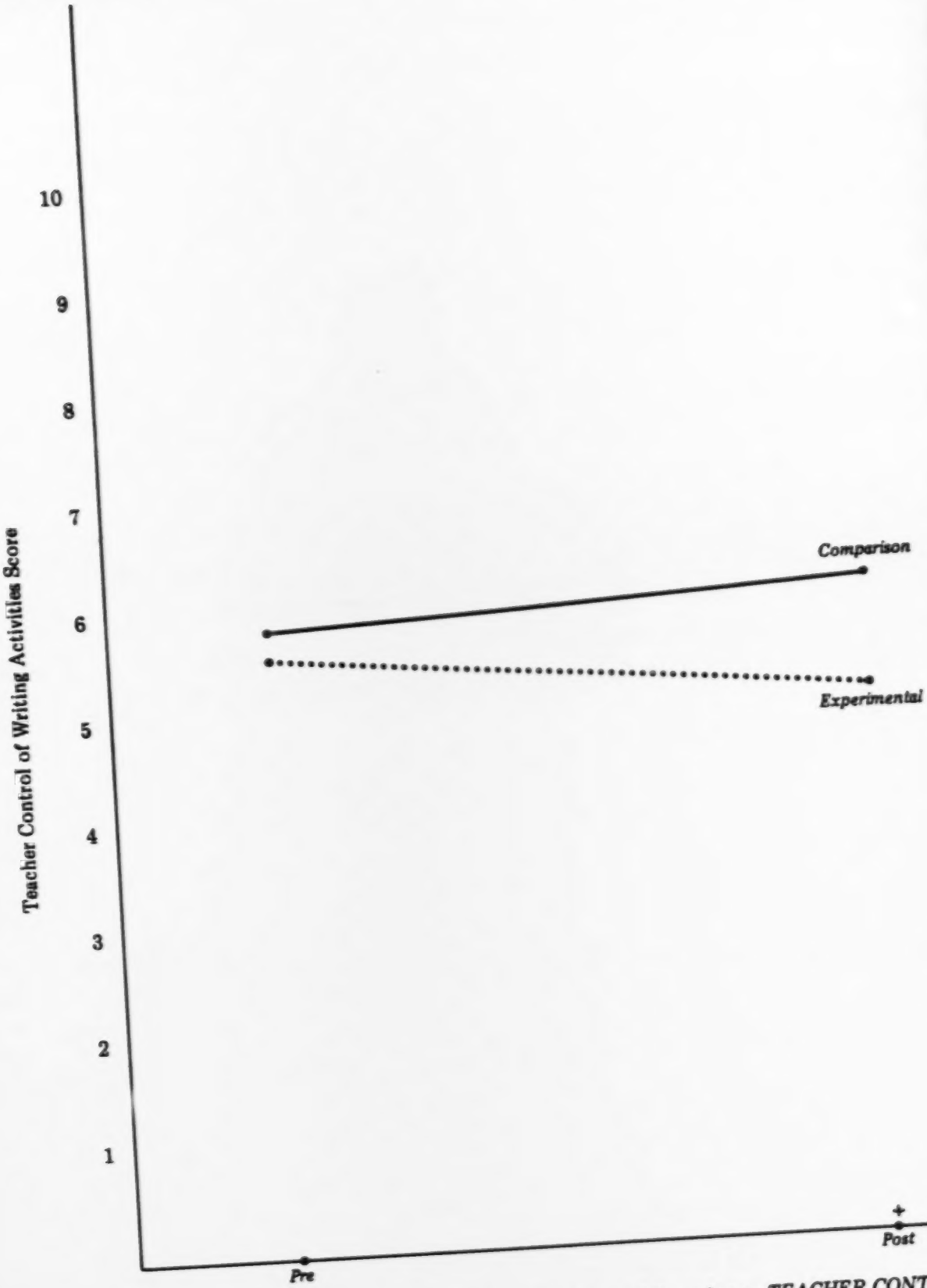

Figure 27. *Teachers' Reports on Writing Activities and Procedures: TEACHER CONTROL OF WRITING ACTIVITIES. Grade 3.*

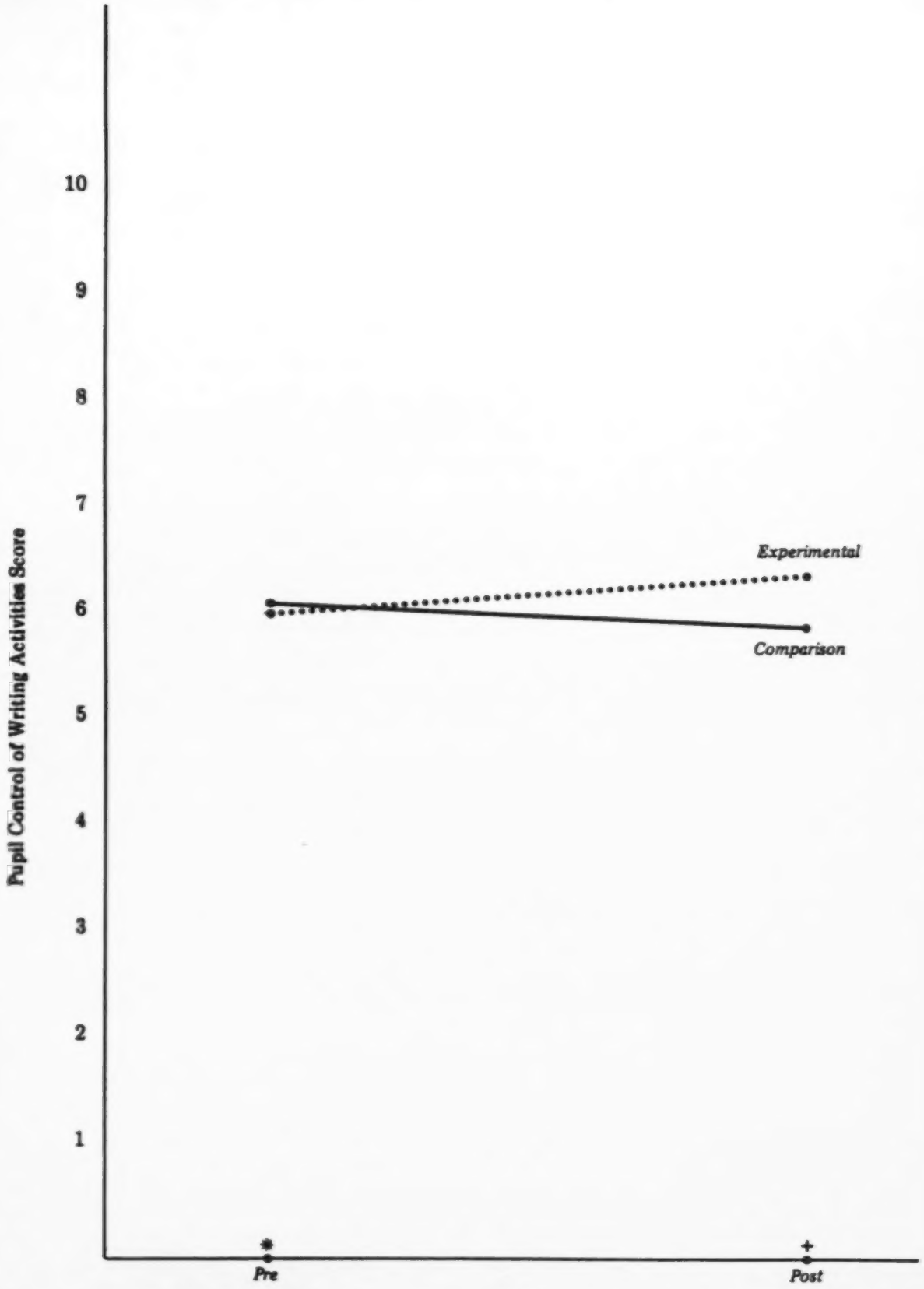

Figure 28. *Teachers' Reports on Writing Activities and Procedures: PUPIL CONTROL OF WRITING ACTIVITIES. Grade 3.*

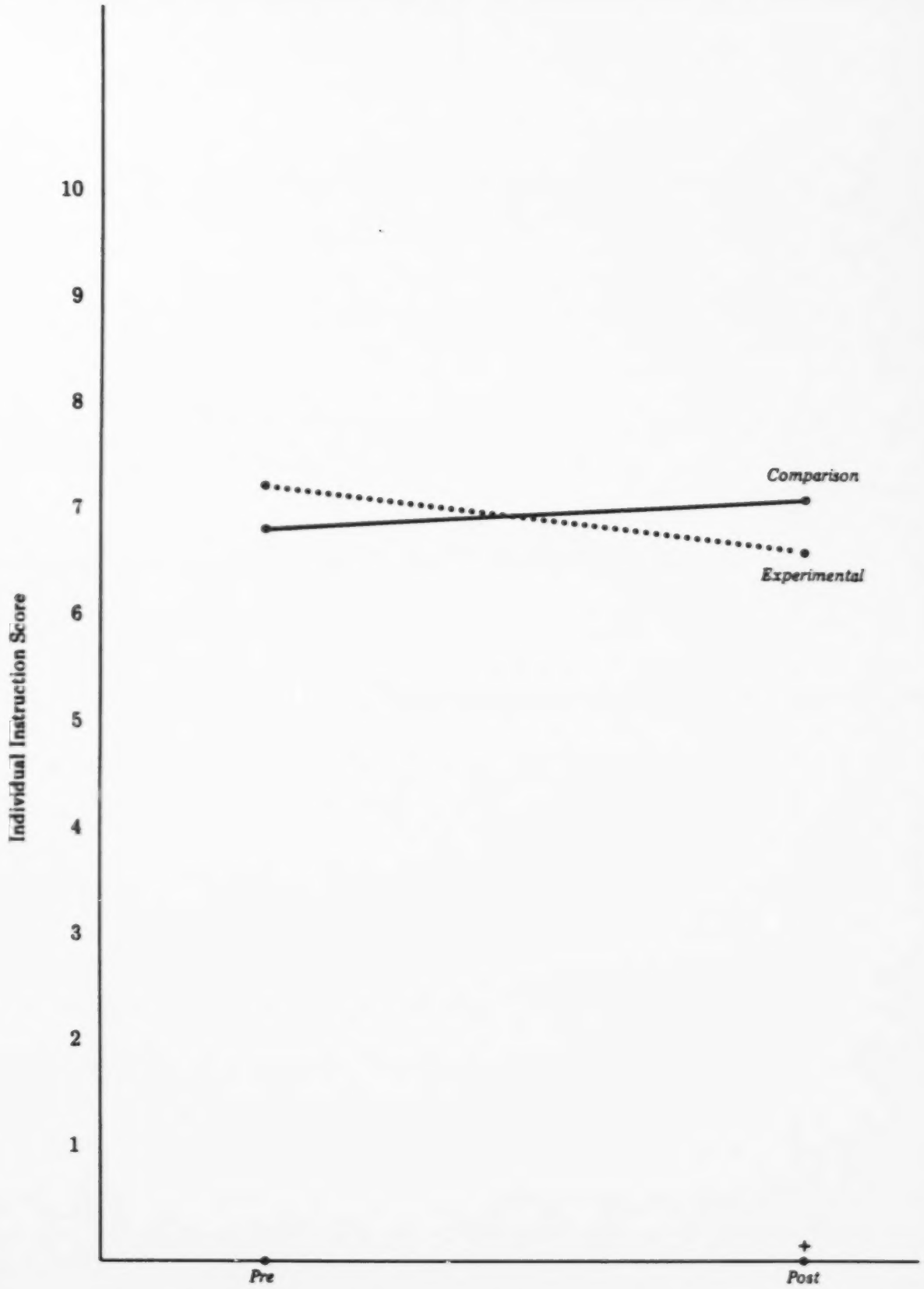

Figure 30. *Teachers' Reports on Writing Activities and Procedures: INDIVIDUAL INSTRUCTION. Grade 6.*

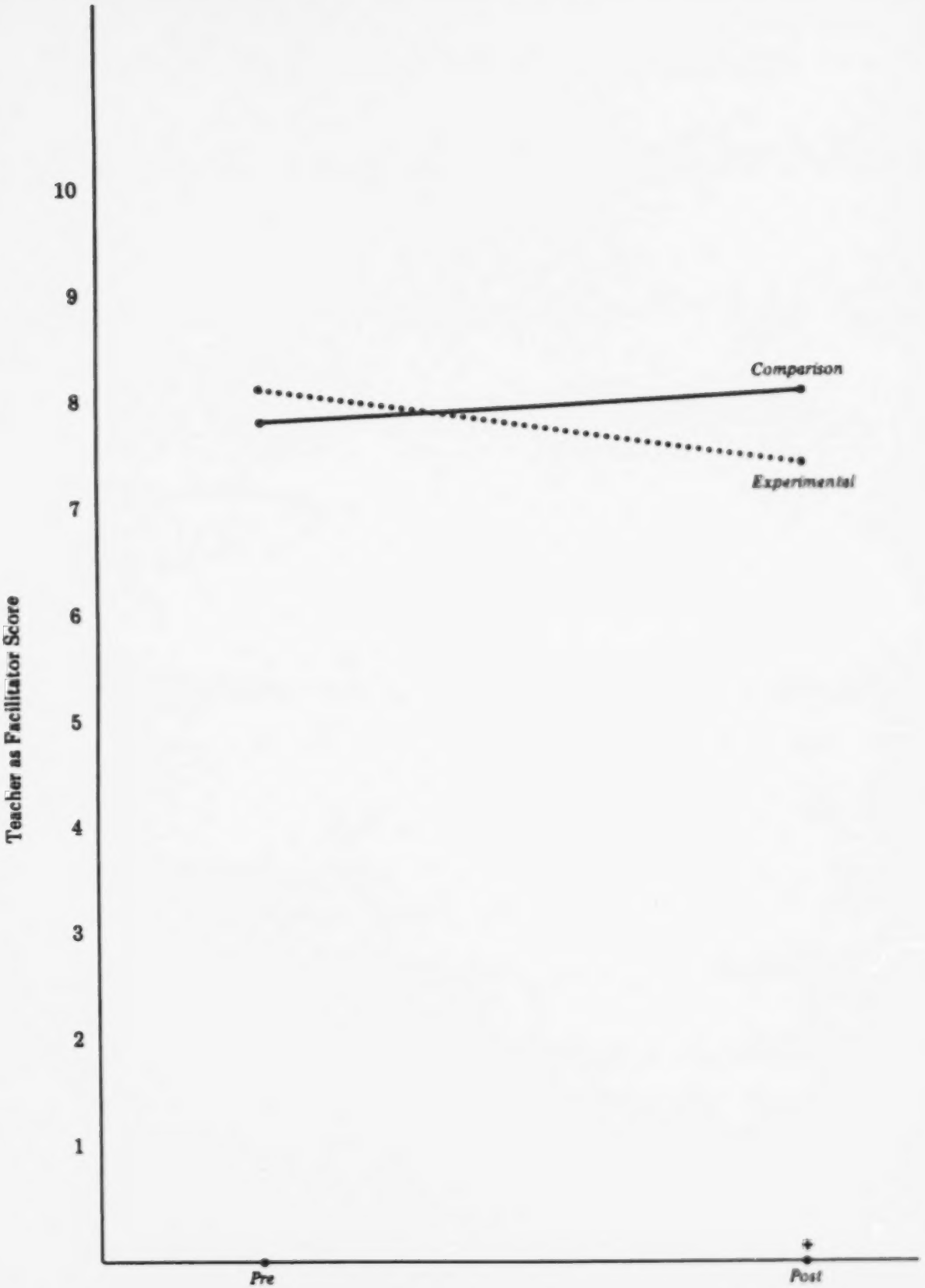

Figure 29. *Teachers' Reports on Writing Activities and Procedures: TEACHER AS FACILITATOR. Grade 3.*

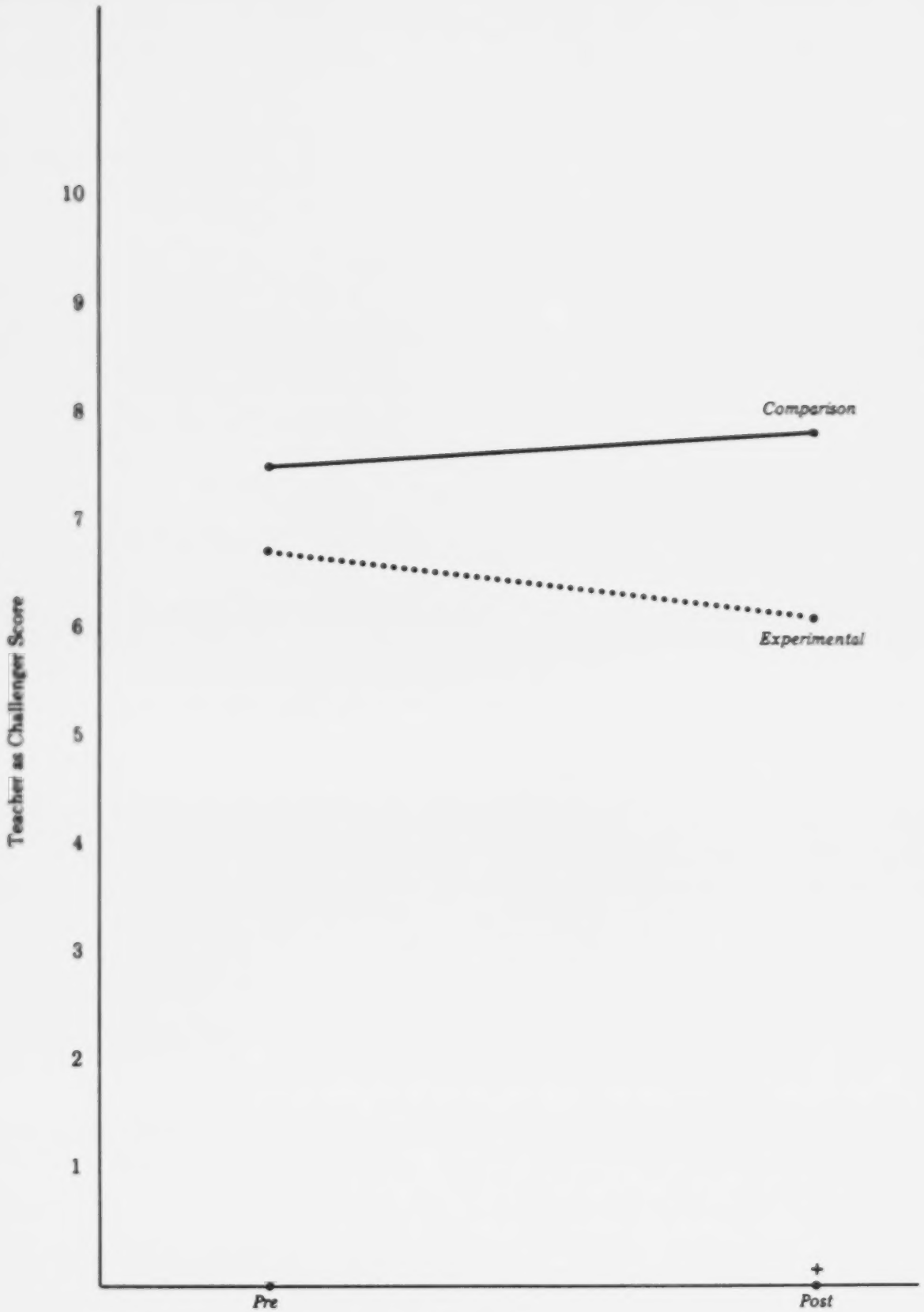

Figure 31. *Teachers' Reports on Writing Activities and Procedures: TEACHER AS CHALLENGER. Grade 6.*

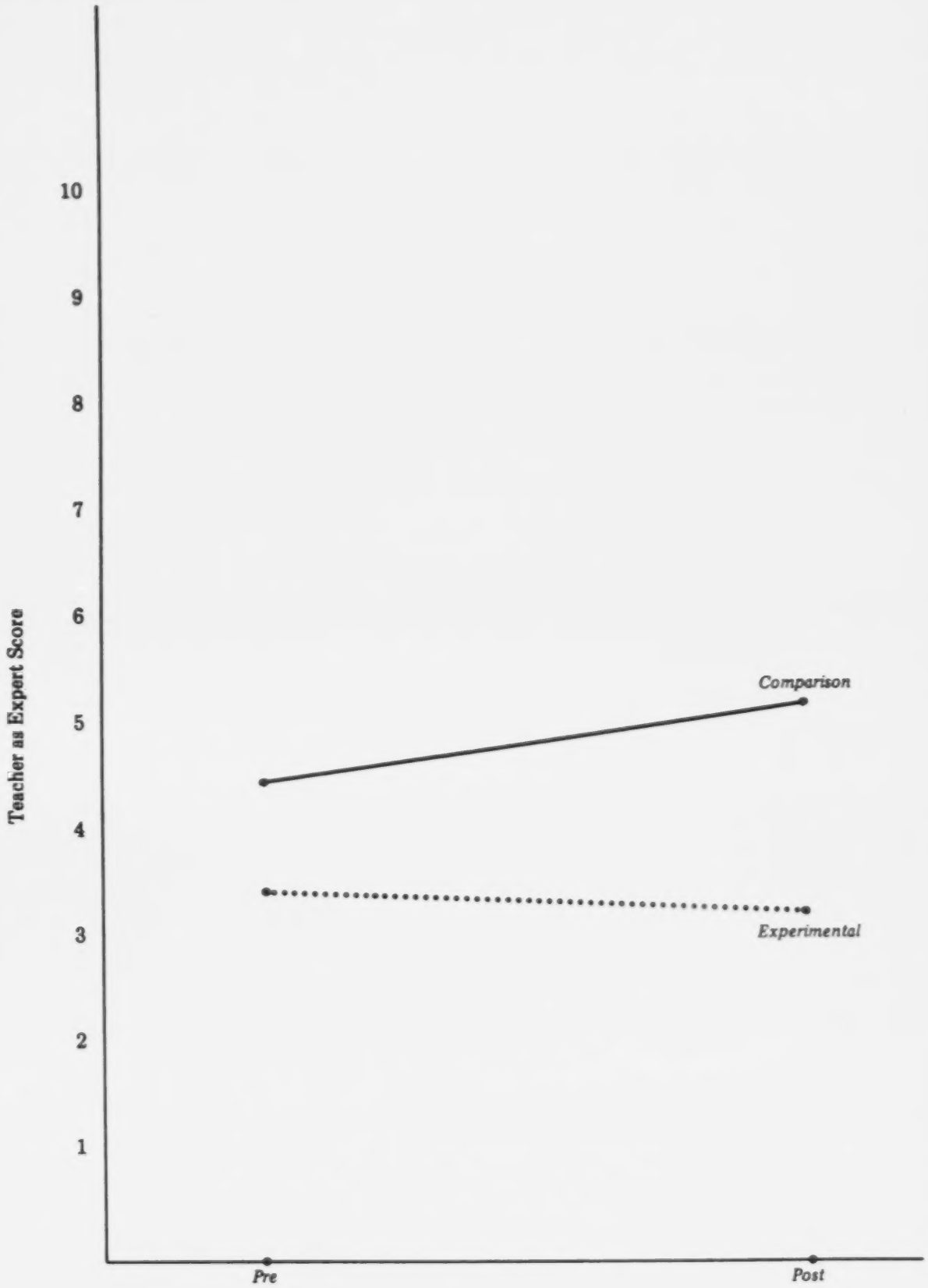

Figure 32. *Teachers' Reports on Writing Activities and Procedures: TEACHER AS EXPERT. Grade 6.*